ATOMKI
ANNUAL REPORT
1994

INSTITUTE OF NUCLEAR RESEARCH
OF THE HUNGARIAN ACADEMY OF SCIENCES
DEBRECEN, HUNGARY

INSTITUTE OF NUCLEAR RESEARCH
OF THE HUNGARIAN ACADEMY OF SCIENCES
DEBRECEN, HUNGARY

ANNUAL REPORT
1994

ATOMKI

Postal address:

Debrecen
P.O.Box 51
H-4001
Hungary

Edited by: Z. Gácsi

HU ISSN0 0231-3596

Preface

In April 1994 the Academy of Sciences Bill was passed with 97% majority by the Hungarian Parliament. This Act and the new Statute of the Academy stabilized the legal status of the research institutes belonging to the Academy of Sciences in Hungary. Not that we could not do our everyday job without this Act and Statute, but we do need them in setting up long-term projects.

Otherwise, 1994 was a quiet year, full of hard work, in the Institute of Nuclear Research. This was the last year for a number of major research projects funded by the Hungarian National Research Fund (OTKA) in experimental and theoretical nuclear physics and in atomic physics. By the time of writing this preface, it has become known that the funding of most of these projects has been renewed, and a few new projects will also be funded.

In 1993 we acquired quite a few new major instruments, and 1994 was the year of the installation of these, and now we are getting the first results. The Silicon Graphics Challenge-L computer was installed a year ago and has been working without problems throughout the year, and for a couple of days it satisfied our gigaflop- and gigabite-eager theorists. At the end of the year it was upgraded to Power Challange L, and the degree of satisfaction now depends on the code very much. Hopefully, the results obtained with the gigaflops and gigabites can be seen in this report.

The GE 4096plus Positron Emission Tomograph (PET) (belonging to the Medical School, but located on the premises of the institute) started to serve as a diagnostic tool. The financing of this project is a burden on the Medical School as well as on our institute, but since it is something like a national project, we bear this burden in the hope that financing will also be solved sooner or later at a national level.

The split-pole magnetic spectrograph produced the first results and from the PIXE microbeam we got the first pictures. The ECR project is progressing according to the schedule. Details can be found in this Annual Report.

Aside from the installations of the new instruments and the first results of their use, the institute continued its activity in the usual fields listed in the table of contents. This was a very productive year in nuclear spectroscopy, and one tends to associate this with the fact that the leading figure in our nuclear spectroscopy program, Prof. Tibor Fényes retired at the end of 1994, and tried to finish all his projects. I hope he did not succeed, so he will continue to contribute to our research. Professor Borbála Gyarmati, our leading theorist and teacher of nearly all of our younger theorists, also retired in 1994. We wish them many happy years in retirement and thank for their work and devotion. I hope that the new staff members enrolled in 1994 will follow our retired professors in their ardent work.

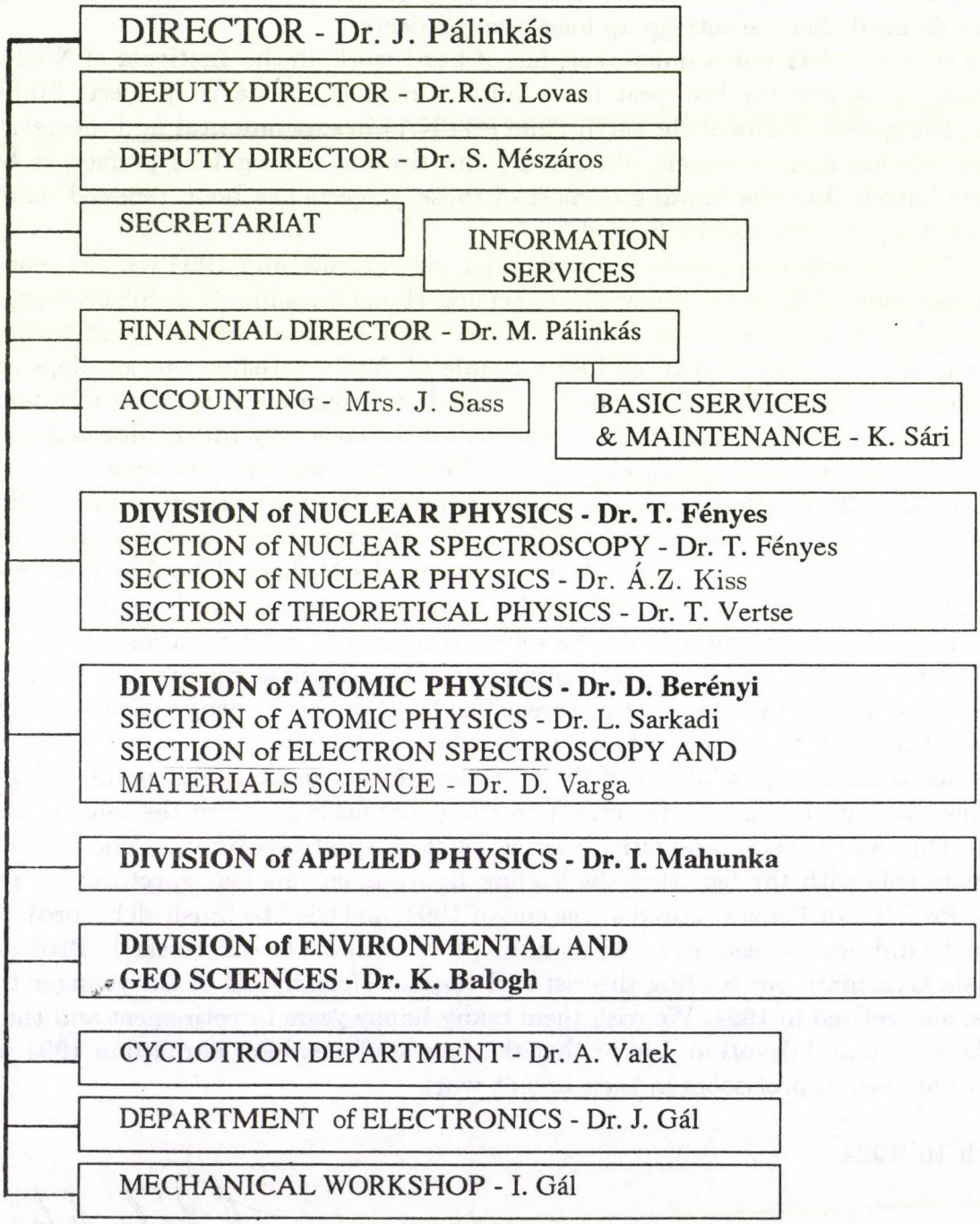
March 16, 1994

Prof. József Pálinkás
director

The organisation structure of the

Institute of Nuclear Research

of the Hungarian Academy of Sciences



CONTENTS

REPORTS:

PUBLICATIONS AND SEMINARS:

GENERAL PHYSICS

A new approximation to the temperature integral

A. Kovách

The so-called "temperature integral" TI = $\int exp(-E/RT)dT$ plays an important role both in physics and chemistry in the modeling of non-isothermal processes governed by an Arrhenius-type dependence of the rate constant on temperature. Since the TI cannot be expressed in a closed analytical form, as an alternative to the programming of one of the existing computational algorithms several approximations applying a polynomial coefficient to the common term $(RT^2/E)exp(-E/RT)$ have been derived to avoid the use of special tables or numerical integration. A critical comparison of several proposed approximations together with the intervals of their applicability is given by Zsakó in [1]. The best approximation yielding an accuracy of better than 0.1 % if $\frac{E}{RT} > 3.23$ and better than 0.2 % if $\frac{E}{RT} > 2.54$ has been derived by Senum and Yang [2] and is referred to in [1] as approximation 10. Some other approximations reach similar accuracies at even lower $\frac{E}{RT}$ values, but the same level of accuracy is not kept in some restricted regions of the higher $\frac{E}{RT}$ values.

The main aim being to extend the applicability of a given approximation in the region of low $\frac{E}{RT}$ values, i.e.towards the region of increased temperatures, but keeping a given level of accuracy in the region of higher $\frac{E}{RT}$ values as well, a new approximation has been derived being similar in its general form to the previous ones, but differing in the polynomial term:

$$TI \approx \frac{1 + 5(RT/E) + (RT/E)^2}{1 + 7(RT/E) + 9(RT/E)^2}(RT^2/E)exp(-E/RT).$$

The given approximation provides an accuracy level of 0.1 % in the entire $\frac{E}{RT} > 2.14$ region and its accuracy is continuously better than 0.2 % if $\frac{E}{RT}$ exceeds the value of 1.91.

References

[1] Zsakó, J., J. Thermal Anal. **34** (1988) 1489.
[2] Senum, G.I. and Yang,R.T., J. Thermal Anal. **11** (1977) 445

Novel approach to the connection between harmonic oscillator and Coulomb potentials

G. Lévai

We have performed further analysis of the generalised Coulomb problem [1] and have shown that besides its Coulomb limit (obtained by setting parameter θ to 0) the harmonic oscillator potential can also be derived from it in the $\theta \to \infty$ limit, provided that parameters $\tilde{C} \equiv C/\theta$ and $\tilde{D} \equiv D/\theta$ assume a finite value [2]. The fourth parameter, β, is related to the orbital angular momentum l in each case, and its value is determined by the number of spatial dimensions (d) considered.

For $d = 3$ $V(r)$, E_n and the wavefunctions are Coulomb-like for small values of θ and large values of r and n, while they have oscillator-like behaviour for large θ's and for small values of r and n. See Fig. 1. for an illustrative example.

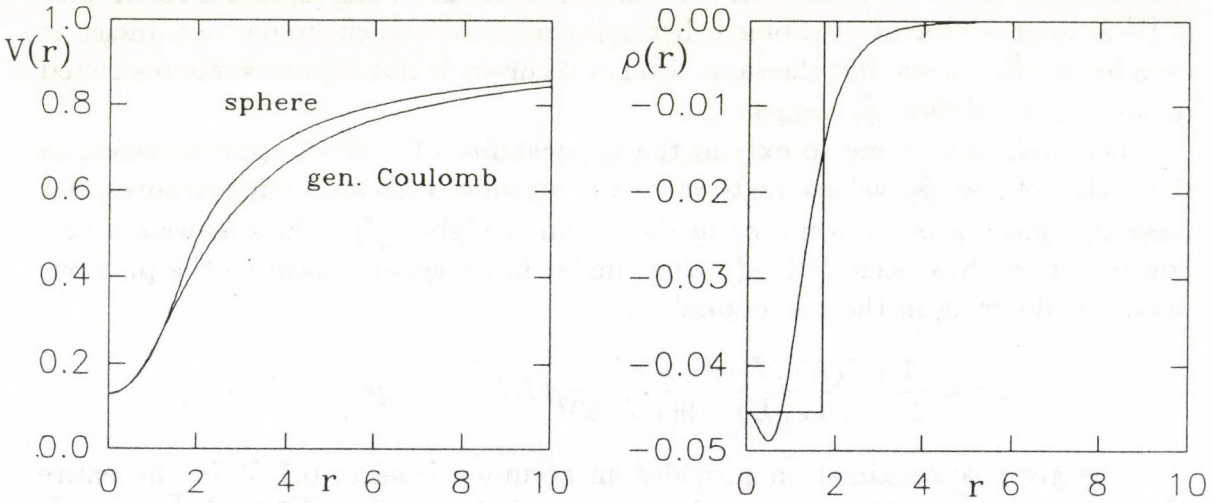


Fig. 1. $V(r)$ compared to the potential of a finite, uniform, spherical charge distribution (left panel), and the respective charge distributions (right panel).

A more natural connection can be established between the Coulomb and harmonic oscillator potentials in 3 and 4 spatial dimensions, respectively, which are also known to be related by the Kustaanheimo-Stiefel transformation. The new element in our approach is that the two potentials are connected continuously.

This work was supported by the OTKA (No. F4303) and by the U.S.–Hungarian Joint Fund (JF No. 345/93).

1. G. Lévai and B. W. Williams: J. Phys. A:Math. Gen. **26** (1993) 3301.
2. G. Lévai: in proc. Second Workshop on Harmonic Oscillators (HO–II), March 23–25, 1994, Cocoyoc, Mexico; in press.

NUCLEAR PHYSICS

Excitation functions of ^{3}He- and α-particle induced nuclear reactions on natural antimony

S. Takács, F. Tárkányi, L. Andó, Cs. Csák, J. Bergman*, S.-J. Heselius*, O. Solin*

* Accelerator Laboratory of Åbo Akademi, Turku, Finland

Excitation functions were measured in collaboration with the Accelerator Laboratory of Åbo Akademi, Turku, Finland using the well-known stacked-foil technique over the energy range from threshold to 28 MeV for ^{3}He-particle and from threshold to 21 MeV for α-particle induced nuclear reactions on natural antimony leading to the formation of ^{121,123,124}I and ^{121m,121g,123m}Te.

High purity natural antimony were vacuum-evaporated onto 13 μm thick kapton ($C_{22}H_{10}O_5N_2$) and 9 μm thick Al backings. Thickness of Sb layers were between 1.17 μm and 0.52 μm determined by weighing and proton activation technique. Total of seven stacks were irradiated with ^{3}He particle beams of primary energy of 28.0 MeV and total of four stacks were irradiated with α particle beams of primary energies 20.0 MeV and 21.0 MeV using the external beam of the MGC-20 cyclotron of Debrecen and Turku for 120 minutes at about 160 nA. The charge was collected in a well-insulated Faraday-cup. Ti foils of 9.6 mg/cm^2 and Ni foils of 8.7 mg/cm^2 were inserted into the stacks and used as monitor foils and energy degraders.

The energy loss of the bombarding particles was calculated according to Ziegler's [1] empirical formulas. The induced activity in each foil was measured via standard high resolution gamma-ray spectroscopy using Ge(Li) and HpGe detectors without chemical separation. All irradiated samples were counted several times to check the half-life and to determine the independent as well as the cumulative cross sections.

Bombarding natural antimony by He ions may allow to produce carrier-free ^{123}I.

References

1. J.F. Ziegler, The stopping and ranges of ions in matter, vol. 4 (Pergamon, New York, 1977)

Excitation functions of ^{3}He-particle induced nuclear reactions on natural nickel

S. Takács, F. Tárkányi, A. Fessler[1], Z.B. Alfassi[1] and S.M. Qaim[1]

[1]Institute für Nuklearchemie, Forshungszentrum Jülich GmbH, D-52425 Jülich, Germany

A general survey showed that for monitoring low and medium energy ^{3}He-particle beams only a few standard reactions are available. The suitable ones are: ^{27}Al(^{3}He,x)^{22}Na [1], ^{nat}Ti(^{3}He,x)^{48}V [2] and ^{nat}Cu(^{3}He,x)^{66}Ga [3-5] processes. To us ^{3}He-particle induced reactions on ^{nat}Ni appeared to be very promising. To cover wider energy range a detailed cross section measurement done in collaboration with the Institute für Nuklearchemie, Forschungszentrum Jülich GmbH, Jülich Germany.

Excitation functions were measured by the well-known stacked-foil technique over the energy range from 2 to 36 MeV for ^{3}He-particle induced nuclear reactions on natural nickel leading to the formation of ^{62,65}Zn, ^{60,61}Cu, ^{55,56,57,58}Co, ^{52,53}Fe and ^{52}Mn. The measured cross sections were considered regarding their potential use as monitor reactions. A total of twelve stacks were irradiated. Irradiation were done at the external beam of the MGC-20E cyclotron, Debrecen and of the compact cyclotron CV-28 at Jülich. Target foils were 99.95% purity nickel foils (10.2, 19.0 and 22.0 mg/cm^{2}) and Cr/Ni-alloy foils (17.5 mg/cm^{2}). Copper and titanium foils were used to monitor the ^{3}He beam and the charge was also collected in a Faraday-cup. The primary ^{3}He-particle energy were 25, 28 and 36 MeV.

The induced activity in each foil were measured via standard high resolution gamma-ray spectroscopy without chemical separation. All irradiated samples were counted several times to check the half-life and to determine independent as well as cumulative cross sections.

The excitation functions for ^{62}Zn, ^{60}Cu, ^{56}Ni and ^{57}Ni exhibit "plateau" over a broad energy range which make them possible to use for determining the flux of bombarding charged particle beam. The use of the excitation functions for the production of ^{55}Co, ^{56}Co, ^{57}Co, ^{58}Co, ^{65}Zn, ^{61}Cu, ^{52}Fe, ^{53}Fe and ^{52}Mn may allow a simultaneous determination of flux and energy of the bombarding particles.

References

1. D.R.F. Cochran et al., Phys. Rev. 128 (1962) 1281
2. R. Weinreich et al., Appl. Radiat. Isot. 31 (1980) 223
3. E.A. Bryant et al., Phys. Rev. 130 (1963) 1512
4. H.H. Bissem et al., Phys. Rev. C22 (1980) 1468.
5. F. Tárkányi et al., Appl. Radiat. Isot. 42 (1991) 513

The S(E) factor of ^{7}Li$(p,\gamma)^8$Be and consequences for S(E) extrapolation in ^{7}Be$(p,\gamma_0)^8$B

D. Zahnow * C. Angulo **, C. Rolfs *, S. Schmidt *

W.H. Schulte * and E. Somorjai

*Institut für Physik mit Ionenstrahlen, Ruhr-Universität Bochum, Germany

**CSNSM, Orsay, France

Excitation functions and forward–backward anisotropies have been measured for the $^7Li(p,\gamma)^8Be$ capture reaction over the proton energy range $E_p = 100$ to 1500 keV, using a 4π summing crystal and Ge(Li) detectors, respectively. The data show at all energies the presence of E1 and M1 capture amplitudes arising from the direct capture (DC) process and the $E_R = 441$ and 1030 keV resonances, respectively. Due to the observed DC process, the present data increase significantly the reaction rates (up to a factor of 110) compared to values given in the compilation. The data and their analyses remove the recent criticism [1] on DC model calculations, which had implied a significant reduction in the extrapolated S(E) factor for ^{7}Be$(p,\gamma_0)^8$B and thus in the predicted flux of high-energy solar neutrinos; thus, the solar neutrino problem is still with us.

Supported in part by OMFB (No. 67.) and OTKA (No. 3008.)

To be published in Z. Phys. (in press).

Reference

1. R.M. Chasteler et al., Phys. Rev. Lett. 72 (1994) 3949.

Electron screening in the ^{9}Be+p reaction

D. Zahnow *, C. Angulo **, C. Rolfs *, S. Schmidt *

W.H. Schulte * and E. Somorjai

*Institut für Physik mit Ionenstrahlen, Ruhr-Universität Bochum, Germany

**CSNSM, Orsay, France

Excitation functions and absolute cross sections have been measured for (p,γ), (p,α) and (p,d) reactions on ^{9}Be target by using NaI, Ge(Li) and surface barrier Si-detectors. The (p,γ) excitation curve and the (p,α), (p,d) cross section values were measured over the proton energy range $E_p = 75$ to 1800 keV and 19 to 100 keV, respectively. In contrary to the enhancement of the S–factor shown by systematic experimental studies of electron screening effects [1], in the ^{9}Be+p case the S–factor steeply drops down by decreasing bombarding energies. It can be caused by some (destructive) interference effects, however, further experimental efforts are needed to give exact explanation of it. Such experiments are in progress.

Reference

1. C. Angulo, S. Engstler, G. Raimann, C. Rolfs, W.H. Schulte and E. Somorjai, Z.Phys. A345 (1993) 231. and references therein.

Astrophysical p–process: $^{70}Ge(\alpha,\gamma)^{74}Se$

Zs. Fülöp, Á.Z. Kiss, E. Somorjai

C.E. Rolfs *, H.P. Trautvetter *

T. Rauscher ** and H. Oberhummer ***

*Ruhr–Universität, Bochum, Germany
**Institut für Kernchemie, Universität Mainz, Germany
***Technische Universität, Institut für Kernphysik, Vienna, Austria

The cross section of the reaction $^{70}Ge(\alpha,\gamma)^{74}Se$ has been measured in the bombarding energy range of $4.90 < E_\alpha < 7.80$ MeV [1,2]. The possible effects of the cascade coincidences on the measured cross sections were investigated by measurements at different target detector distances. Coincidence measurements ($\gamma\gamma$) were performed in Bochum for identifying the peaks connected to the transition between the first excited and the ground state (E_γ=635 keV) on a reduced background. The resulted S–factor values are in satisfactory agreement with the statistical model calculations. The ^{74}Se is the lightest p–nucleus as well as a waiting point in the astrophysical p–process, consequently, the reaction rates for the inverse (γ,α) reaction have been determined [3].

This work was supported by OMFB (No. 67., No. A1.) and OTKA (No. 3008.).

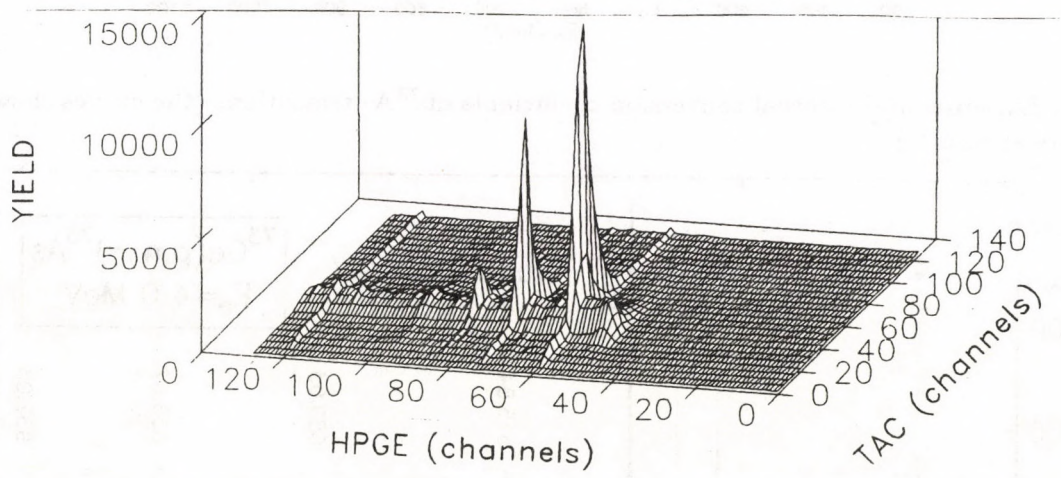


Fig. 1. Dual parameter histogram of a high efficiency γ–detector (HPGE) and a time spectrum (TAC). The peaks represent transitions in ^{74}Se in coincidence with E_γ=635 keV.

References

1. Zs. Fülöp et al., ATOMKI Ann. Rep. 1993, p. 21.
2. Zs. Fülöp et al., Proceedings of the European Workshop on Heavy Element Nucleosynthesis, Budapest, 9–11. March 1994, p. 86.
3. Zs. Fülöp et al., Proc. Int. Conf. on Nuclear Astrophysics, "Nuclei in the Cosmos", Gran Sasso 1994 (in press)

Study of ^{73}Ge(p,nγ)^{73}As Reaction

Zs. Podolyák and D. Sohler

As a continuation of our study of the ^{73}As [1], γ-ray, internal conversion electron, and $\gamma\gamma$-coincidence spectra were measured with Ge(HP) γ- and superconducting magnetic lens plus Si(Li) e^--spectrometers between 1.9 and 4.0 MeV beam energies. Internal conversion coefficients of 28 transitions (Fig. 1) have been deduced for the first time [2]. A typical $\gamma\gamma$-coincidence gate spectrum is shown in Fig. 2.

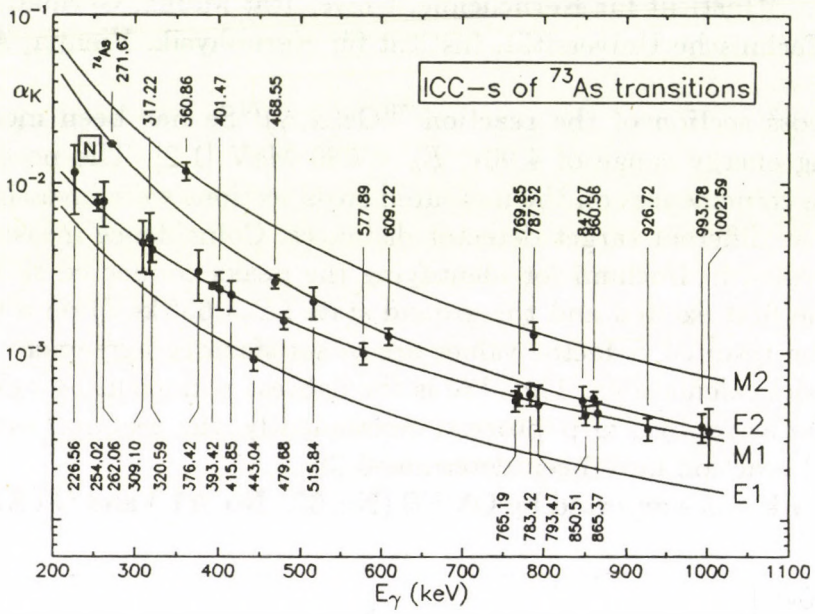


Fig. 1. Experimental internal conversion coefficients of ^{73}As transitions (the curves show theoretical results).

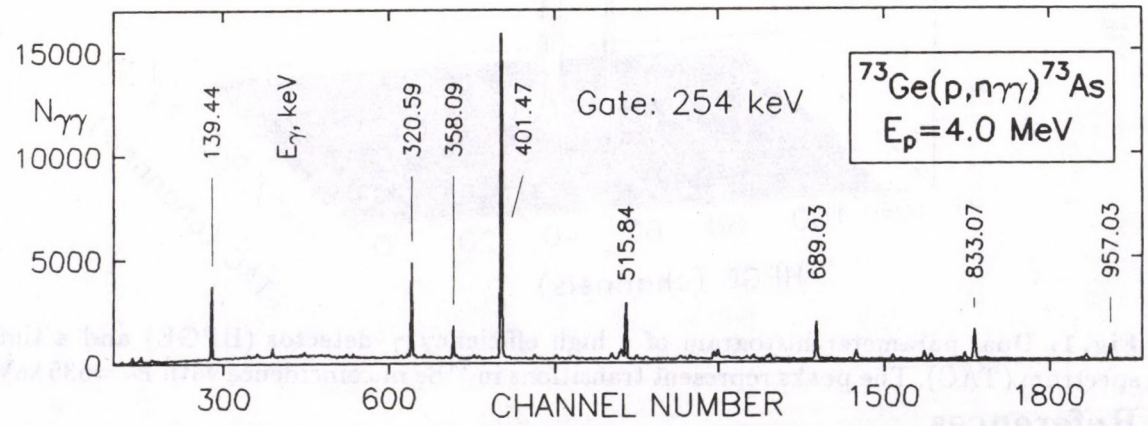


Fig. 2. Typical $\gamma\gamma$-coincidence gate spectrum of ^{73}As.

1 D. Sohler and Zs. Podolyák, ATOMKI Ann. Rep. 1993, p. 18.
2 M. M. King, Nucl. Data Sheets **51** (1987) 161

Predicted low-lying states of ^{100}In

Zs. Dombrádi, A. Algora, S. Brant+ and V. Paar+

+ Department of Physics, University of Zagreb, 41000 Zagreb, Croatia

The low–lying states of ^{100,102}In became important in connection with the search for ^{100}Sn. Experimentally the structure of ^{100}In is unknown, while some of the high spin states of ^{102}In were investigated recently. To predict the probable energies of the other states of interest extrapolations from systematic studies can be used. The structure of odd-odd $^{104-116}$In nuclei has been successfully described with help of the interacting boson-fermion-fermion-model (IBFFM). Energy systematics of the odd-odd In nuclei have been recalculated in the framework of IBFFM to obtaine a homogeneous parametrization. Using this parameter systematics, predictions were made on the energies of the p–n multiplet states of ^{100,102}In. The model predictions gave a nice agreement with the available experimental data on ^{102}In.

The calculations for ^{100}In were reduced to a simple 2 particle shell model calculation, using delta interaction. The predicted splittings of the low lying multiplets are shown in Fig. 1. The most striking feature of this description is the predicted low energy of the 1_1^+ state originating from the $\pi g_{9/2}^{-1} \nu g_{7/2}$ multiplet. This is about 1.5 MeV lower than the energy predicted by the shell model calculations. The large difference is probably due to the strong lowering of the energy of the $\nu g_{7/2}$ state obtained from the systematics.

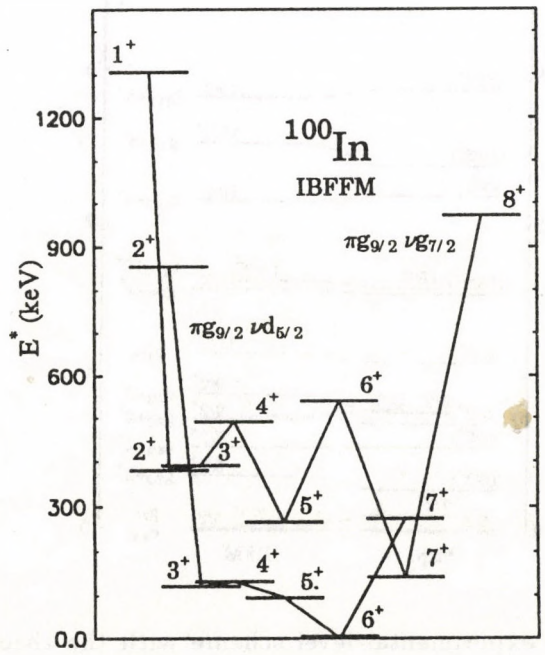


Fig. 1. Low–lying states of ^{100}In predicted by IBFFM. States belonging to the same multiplet are connected.

High spin spectroscopy of ^{109}Te

Zs. Dombrádi, B. M. Nyakó, G. E. Perez, A. Algora and the NORDBALL collaboration

Excited states of the neutron deficient nucleus ^{109}Te were identified for the first time in the ^{54}Fe(^{58}Ni,2pn) reaction by in-beam γ-spectroscopic methods. The NORDBALL detector array, equipped with a charged-particle and a neutron detector system for reaction channel identification, was used to detect the evaporated particles and γ rays. A level scheme was constructed on the basis of $\gamma\gamma$-coincidence relations, and the angular momenta of the states were determined from the measured angular correlation intensity ratios. Two favoured bands built on the $\nu g_{7/2}$ and $\nu h_{11/2}$ neutron quasi-particle states were identified. The structure of the nucleus is discussed in the framework of the particle–vibration coupling model using the interacting boson-fermion formalism up to spin 27/2. The negative parity sequence is compared to Total Routhian Surface calculations.

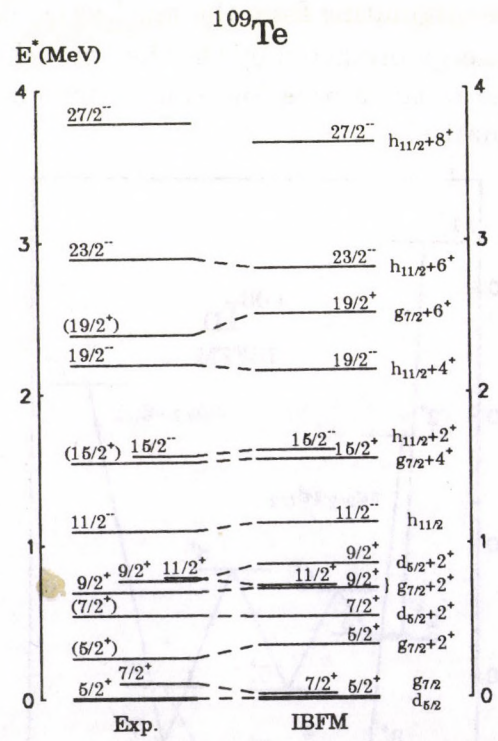


Fig. 1. Comparison of the experimental level scheme with the theoretical calculations based on the interacting boson–fermion model. On the right hand side of the figure the main components of the calculated wave functions are also given.

Background subtraction in particle-$\gamma\gamma$ measurements

Zs. Dombrádi B. M. Nyakó M. Józsa

Great interest is shown in identification and study of the structure of nuclei close to the proton drip line. Nuclei so far from the stability line are produced with very low cross sections. For their identification the use of highly efficient and selective reaction channel separation is required. This is performed by using numerous charged particle and neutron detectors in addition to the gamma detectors. The events collected in such a measurement are sorted into a set of $\gamma\gamma$ matrices by requiring different conditions on the number of detected charged particles and neutrons. In spite of these conditions, the matrices contain γ rays from several final nuclei, as some of the emitted particles have been undetected or misidentified.

The contaminating γ lines can be eliminated by using a successive matrix subtraction technique. Starting with the highest but one multipolarity channel, one can subtract the contribution of the highest one than from the highets but two multipolarity channel the contribution of the highest and the highest but one multipolarity channels can be subtractad independently, and so on.

For this method no explicit identification of the contaminating nuclei is necessary. It can be done very fast, if instead of the matrices the succesive substraction is preformed with the total projection spectra. When making the linear combination of the matrices care must taken for matricies with low statistics and integer representation.

The method was applied at the study of light Te nuclei [1,2]. The total projection spectrum of the cleaned matrix obtained for ^{110}Te is shown in Fig. 1. In this case $\approx$ 3 order of magnitude bacground suppression could be achived.

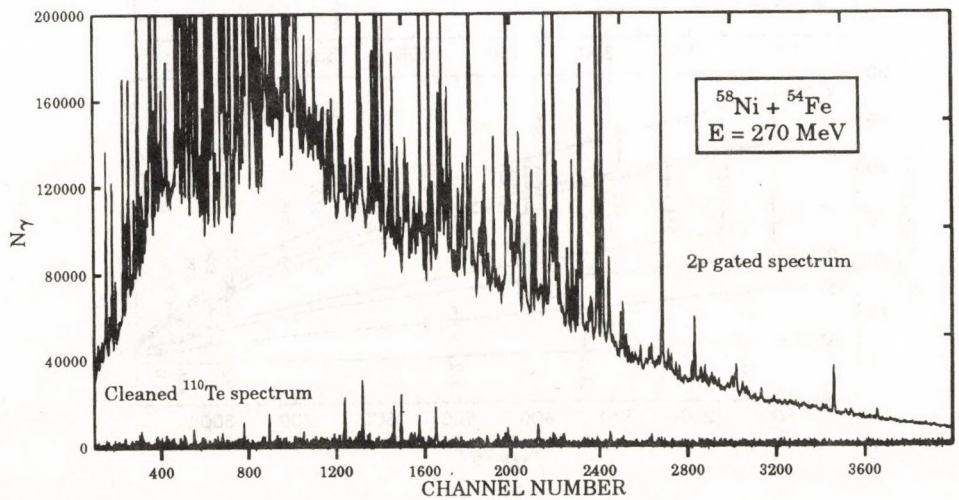


Fig. 1. Spectrum obtained in the ^{54}Fe(^{58}Ni,2p) channel and the cleaned spectrum of ^{110}Te.

[1] Zs. Dombrádi *et al.*, Z. Phys. A **350**, 3 (1994).
[2] C. Fahlander *et al.*, Nucl. Phys. **A577**, 773 (1994).

Spectroscopy of ^{112}Sb nucleus

M. Fayez Hassan, J. Gulyás, Zs. Dombrádi and I. Dankó

As a continuation of the spectroscopic study of ^{112}Sb [1], the spin values of the levels have been determined. They were deduced from the mesured internal conversion coefficients, angular distributions of the gamma rays and from the Hauser-Feshbach analysis, based on the spin dependence of the cross sectións of excitation of different states in the (p,n) reaction, applied in the present study.

New internal conversion coefficients have been determined for 37 transitions from the conversion electron spectroscopic measurement [1], and angular distribution information could be deduced for more than 20 ^{112}Sb γ rays from the measurement of the angular distribution of the γ rays.

The experimental (p,n) cross sections obtained from γ-ray mesurements are compared with the calculated values in Fig. 1.

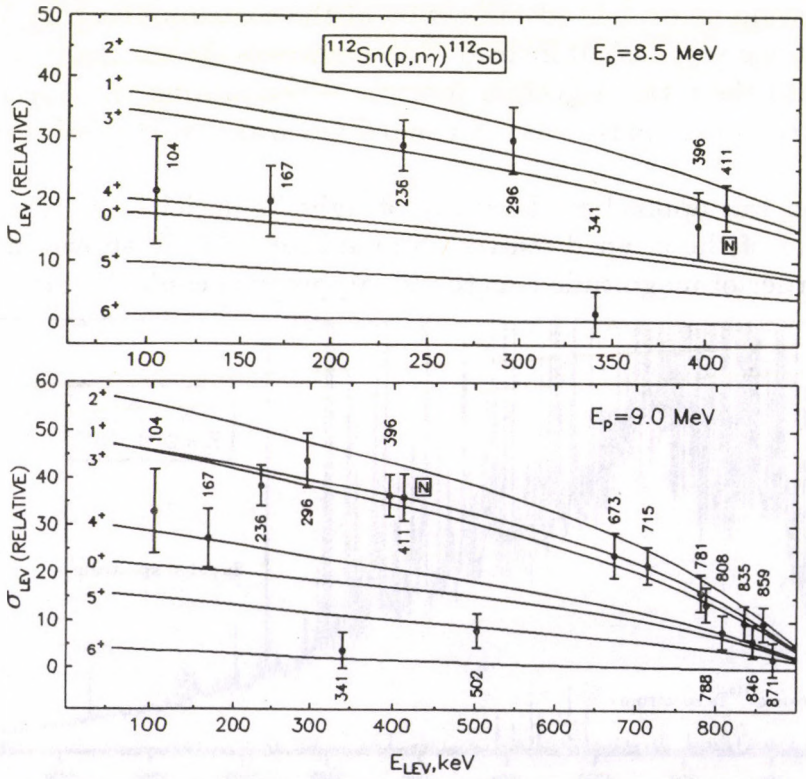


Fig. 1. Experimental (circles with error bars) and theoretical (curves) relative level cross section for ^{112}Sb as a function of excitation energy. N denotes normalization point.

[1] J. Gulyás, I. Dankó, J. Kumpulainen and R. Julin, ATOMKI Ann. Rep. 1992, p.22.

Parabolic rule description of ^{114}Sb

Zs. Dombrádi and Z. Gácsi

In the $^{114}_{51}Sb_{63}$ nucleus we may expect excitations of the odd proton and odd neutron, and the angular momentum coupling of different excited states. In zeroth-order approximation the energy of the p–n multiplet can be obtained by addition of energies of the odd proton and odd neutron states. According to Fig. 1.(a), the lowest lying states of ^{114}Sb are expected to be members of the proton-neutron multiplets predominantly based on the $\pi d_{5/2}$ proton configuration. To estimate the splitting of the different multiplets we performed a parabolic rule calculation. The result of the calculations are presented in Fig. 1.

The experimental states [1] could be associated with the calculated ones on the basis of the energies and spins, and the dominant decay mode, since in the quasiparticle shell model strong ($\approx$ 1 Weisskopf unit) M1 transitions are expected between the J and $J \pm 1$ members of the multiplets.

Up to 700 keV all but 2 states were identified as quasi-particle state, using the parabolic rule. The two unidentified states are expected to arise from one phonon multiplets.

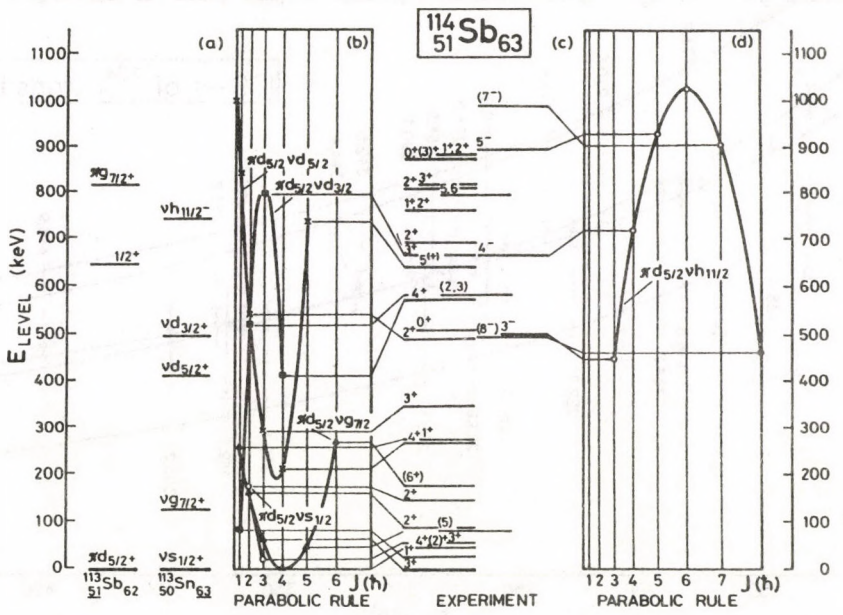


Fig. 1. Proton-neutron multiplet states in ^{114}Sb. (a): Experimental level energies and configurations of the lowest-lying states of ^{113}Sb and ^{113}Sn. (b) and (d): Results of the parabolic-rule calculations for positive- and negative-parity states. The abscissa is scaled according to $J(J+1)$, where J is the spin of the state. (c): Experimental results on ^{114}Sb levels.

[1] Z. Gácsi and Zs. Dombrádi, Phys. Rev. C **50** (1994) 1833

Study of ^{124}I from ^{124}Te(p,nγ)^{124}I reaction

I. Dankó, J. Gulyás and M. Fayez Hassan

As a continuation of the study of the structure of ^{124}I [1], new γ-ray, internal conversion electron as well as $\gamma\gamma$-coincidence spectra from the ^{124}Te(p,nγ)^{124}I reaction were measured with Ge(HP) and superconducting magnetic lens plus Si(Li) electron spectrometers (SMLS) at 6.5 and 6.9 MeV proton energies.

Approximately 12 million $\gamma\gamma$-coincidence events were recorded with four Ge detectors. Standard gating procedure was applied for the analysis of the coincidence relations. Numerous previously unobserved coincidence relations were found. On the basis of the coincidence measurement the level scheme of ^{124}I [2] was significantly extended.

Internal conversion coefficients (ICC) of about 25 transitions have been determined for the first time, which enabled the determination of a lot of new γ-ray multipolarities (Fig.1). For the normalization of the experimental ICC-s the α_K=0.136 value of the 188.4 keV ^{125}I transitions was used [3]. ICC-s obtained in this way are in good agreement with the former results for ^{124}I and ^{125}I transitions.

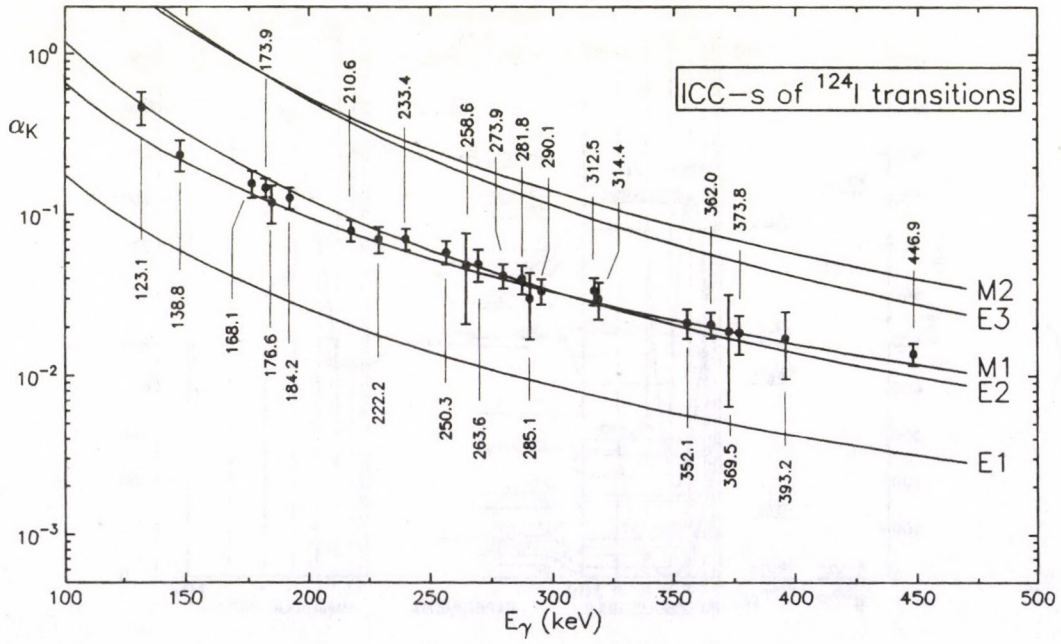


Fig. 1. Experimental internal conversion coefficients of ^{124}I transitions (the curves show theoretical results).

[1] I. Dankó, J. Gulyás and M. Fayez Hassan, ATOMKI Ann. Rep. 1993, p.26.
[2] T. Tamura, K. Miyano and S. Ohya, Nucl. Data Sheets **41** (1984) 413.
[3] J. Katakura, M. Oshima, K. Kitao and H. Iimura, Nucl. Data Sheets **70** (1993) 217.

In-beam spectroscopy of ^{126}I

M. Fayez Hassan, J. Gulyás, I. Dankó and Zs. Dombrádi

The investigation of ^{126}I nucleus [1] have been continued with measuring $\gamma\gamma$-coincidences from the ^{126}Te(p,nγ)^{126}I reaction at 6.5 MeV bombarding proton energy using four Ge(HP) detectors placed at 45°, 135°, 225° and 315° angles to the beam direction. The time window was set to 100 ns.

About 12 million $\gamma\gamma$ coincidence events were acquired on magnetic tape in event-by-event mode, and later a $\gamma\gamma$ matrix was created from the list. Standard gating procedure was used to create the coincidence spectra. Typical $\gamma\gamma$ coincidence gate spectra are shown in Fig. 1. Numerous new coincidence relations were found, which enables a significant extension of the level scheme of ^{126}I.

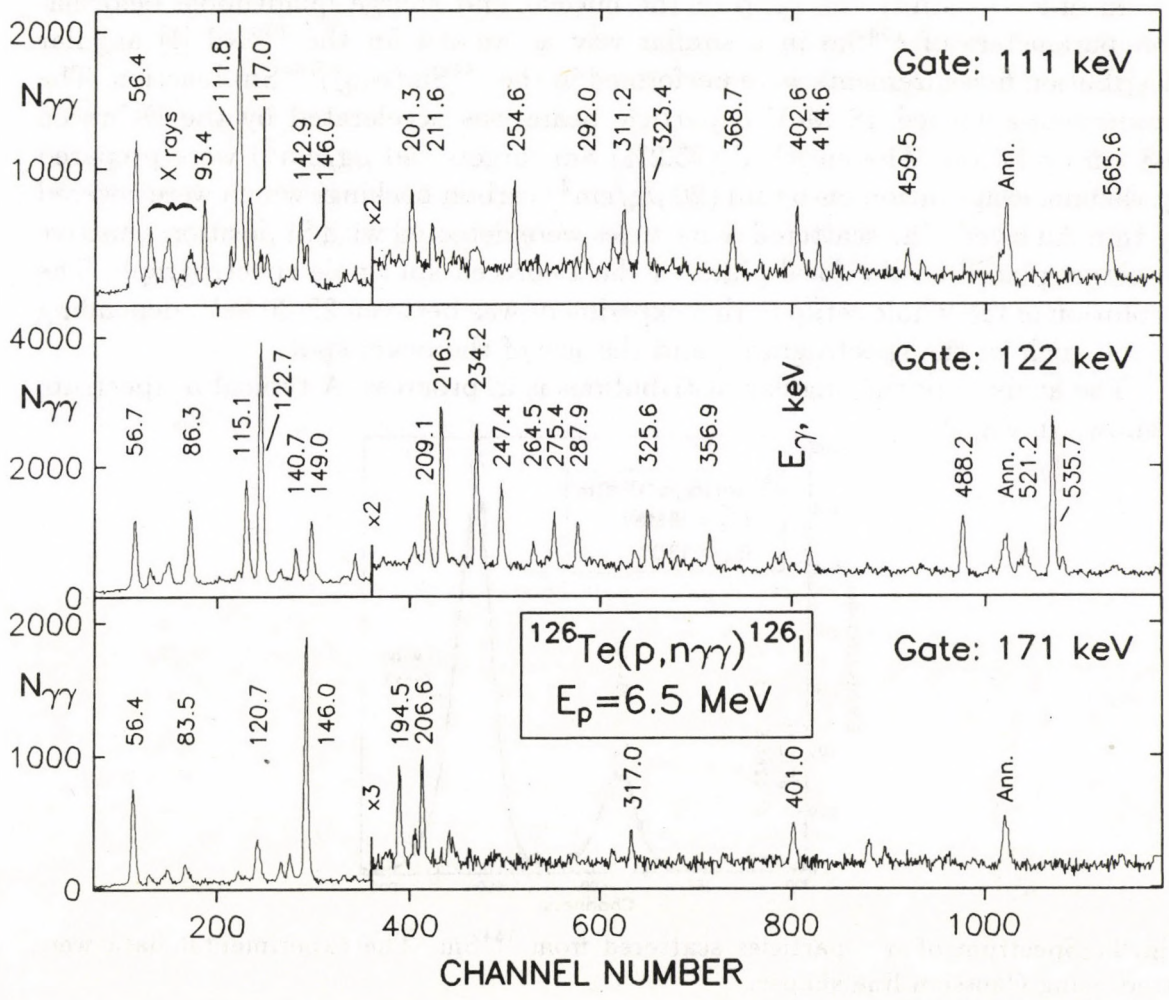


Fig. 1. Typical $\gamma\gamma$ coincidence gate spectra of ^{126}I. The background was subtracted.

[1] M. Fayez Hassan, J. Gulyás and I. Dankó, ATOMKI Ann. Rep. 1993, p.27.

Nuclear quadrupole deformation parameter of ^{154}Sm from ^{154}Sm(α,α') inelastic scattering

M. Csatlós, J. Gulyás, A. Krasznahorkay and Z. Máté

The properties of the rare - earth atomic nuclei have special features in different respect. The characteristics of the charge and nuclear distributions may express curious behaviour for these nuclei. These characteristics can be well studied by charged projectiles of energy close to the Coulomb barrier. At this energy the cross sections are quite sensitive to the interference of the Coulomb and nuclear contributions. This sensitivity provides a tool for analysing the quadrupole deformation parameter of the nuclear distribution β_2^n.

In order to study the ratio of the nuclear and charge quadrupole deformation parameters of ^{154}Sm in a similar way as we did for the ^{150}Nd [1] angular distribution measurements were performed in the ^{154}Sm(α,α')^{154}Sm reaction. The momentum-analyzed 18 MeV α-particle beam was accelerated by the Debrecen 103 cm cyclotron. The enriched (95.2%) Sm targets (50 $\mu g/cm^2$) were prepared by vacuum evaporation onto thin (20 $\mu g/cm^2$) carbon backings which were covered by thin Au layer. The scattered α-particles were detected with Si position sensitive detectors placed at the focal plane of the Debrecen split-pole spectrograph. The resolution of the whole setup in this experiment was between 22-30 keV, depending on the angle of the spectrograph, and the size of the beam spot.

The analysis of the angular distributions is in progress. A typical α–spectrum is shown in Fig. 1.

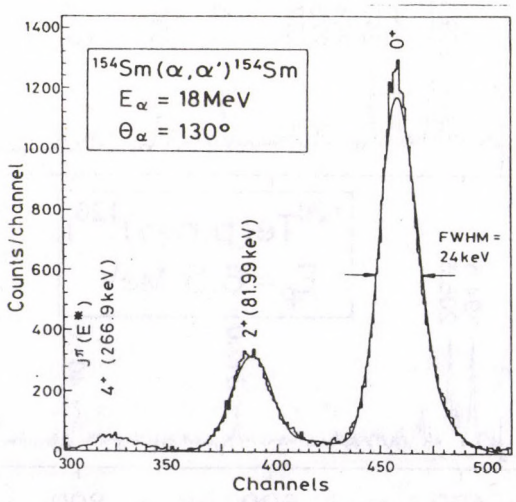


Fig. 1. Spectrum of α - particles scattered from ^{154}Sm. The experimental data were fitted using Gaussian line shapes.

This work was supported by the OTKA Foundation, No: 7486.

1. A. Krasznahorkay et al., Proc. of the IV. Int. Conf. on Selected Topics in Nuclear Structure, Dubna, 5 - 9 July 1994.

Highly deformed states observed in the $^{235}U(d,pf)^{236}U$ reaction

M. Hunyadi, M. Csatlós, I. Diószegi *, J. Gulyás, A. Krasznahorkay,

Z. Máté and B.M. Nyakó

* Institute of Isotopes of the Hungarian Academy of Sciences, Budapest

In order to study the super- and hyperdeformed states in the second and third minimum of the potential energy surface of ^{236}U the transmission resonances of the fission probability were investigated in the $^{235}U(d,pf)$ reaction. The experiment was carried out at the Debrecen 103-cm isochronous cyclotron at $E_d = 9.73$ MeV. Enriched $^{235}UF_4$ (97.6 %) target with a thickness of 250 $\mu g/cm^2$ was used for the proton – fission fragment coincidence measurements. The energy of the outgoing protons was analysed by a split-pole magnetic spectrograph ($\Theta = 130^o$) while the fission fragments were detected by a large area parallel plate avalanche counter ($\Theta = 90^o$). The overall proton energy resolution was ≤ 20 keV. A characteristic part of the proton spectrum in coincidence with the fission fragments is shown in Fig. 1.

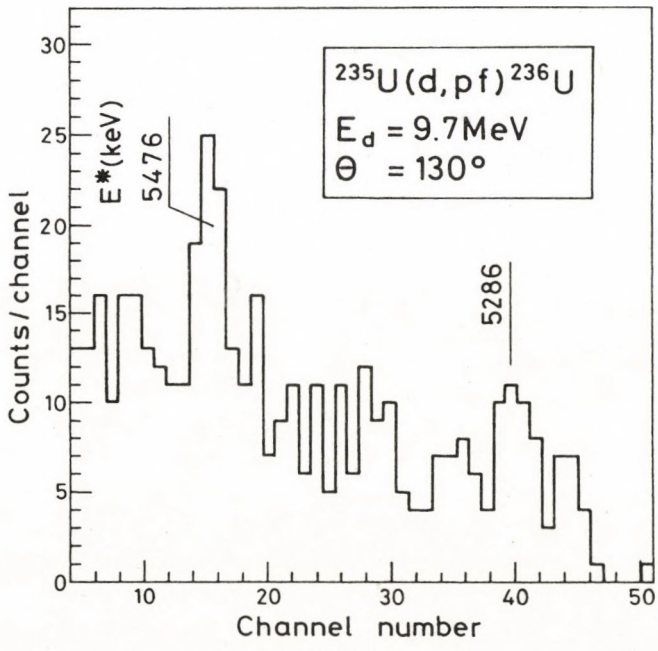


Fig. 1. Proton energy spectrum from the $^{235}U(d,pf)^{236}U$ reaction in coincidence with the fission fragments as a function of the excitation energy.

Strong and well separated resonances have been obtained at $E^* = 5.476$ MeV and 5.286 MeV. The average distance of the superdeformed states is expected to be about 30 - 40 keV at the corresponding excitation energy of 2.73 MeV in the second well, which is much smaller than the energy difference between the two observed resonances. There are, however weak structures in Fig. 1. near E^*=5.286 MeV, which could correspond to superdeformed states. In interpreting the resonance at E^*=5.476 MeV an analogy can be drawn with the case of ^{237}U, where the excitation energy of the bottom of the third well was measured to be 5.5 MeV [1] being very close to our strongest observed resonance. This may suggest that in ^{236}U we have seen some low-lying state(s) also in the third well with an axis ratio of 3:1.

We are going to improve the energy resolution of the system and perform angular distribution measurements too for the fission fragments in order to resolve and identify the hyperdeformed ground-state rotational band to get some more insight into the structure of such highly deformed states.

This work has been supported by the OTKA Foundation, No: 7486.

References

[1] J. Bloons et al., Nucl. Phys. **A477** (1988) 231

Multichannel dynamical symmetries

J. Cseh

The concept of dynamical symmetry proved to be a fruitful tool of analysing complex nuclear spectra. A dynamical symmetry holds, if the Hamiltonian of the system can be expressed in terms of the invariant operators of a group chain:

$$G \supset G' \supset G'' \supset ...$$

Recently we have pointed out the possibility of a new type of dynamical symmetry in atomic nuclei that is related to the cluster configurations, and has a multichannel character, i.e. it connects different fragmentations [1].

The multichannel dynamical symmetry can be formulated in the framework of the semimicroscopic algebraic cluster model [2,3]. If we consider a system of two clusters, and only one of the clusters has internal degrees of freedom, but it is a spin-isospin scalar, the model has a $U_C^{ST}(4) \otimes U_C(3) \otimes U_R(4)$ group structure. Here C refers to cluster, R to relative motion, and $U_C^{ST}(4)$ is Wigner's spin-isospin group. The dynamical symmetry of the model is given by the group-chain:

$$U_C(3) \otimes U_R(4) \supset U_C(3) \otimes U_R(3) \supset U(3) \supset SU(3) \supset O(3) \supset O(2).$$

The basis states are characterised by the representation labels of these groups, and the physical operators are expressed in terms of their generators.

Due to the effects of the antisymmetrization the wave functions of seemingly different clusterizations can be identical in the $U(3)$ limit. If we require the equality of the matrix elements between the corresponding basis states of different clusterizations, we can build up a relation of the physical operators (e. g. Hamiltonians) of various cluster configurations.

The multichannel dynamical symmetry provides us with the possibility of describing the experimental data with strong constraints, inasmuch the energy spectra, transition ratios etc. of different reactions are treated in this framework simultanously.

This work was supported by the OTKA (Contract No. T14321.) and by the PHARE ACCORD Programme (Contract No. H9112-0694).

[1.] J. Cseh: Phys. Rev. **C50** (1994) 2240
[2.] J. Cseh: Phys. Lett. **281B** (1992) 173
[3.] J. Cseh and G. Lévai: Ann. Phys. (N.Y.) **230** (1994) 165

Spectra of heavy ion resonances in terms of multichannel dynamical symmetries

J. Cseh and G. Lévai

The spectra of the heavy ion resonances is usually far too complicated for a fully microscopic description. On the other hand their phenomenological treatment contains a considerable amount of ambiguity due to the less well-defined band structure, and the corresponding association of the quantum numbers. Recently we have shown [1] that within the framework of the semimicroscopic algebraic cluster model [2,3] the simultaneous description of the ground-state-region and highly excited cluster states can reduce this kind of ambiguity to a large extent. A description based on a single cluster configuration can be carried out if this cluster structure is characteristic for the heavy ion reaction and it can also be present in the ground-state-region of the compound nucleus (e.g. ^{24}Mg in terms of ^{12}C+^{12}C). For some systems this is the case, but in general it is not [4].

It is more typical, that the core-plus-alpha-particle configuration is allowed in the ground-state-region, while the configuration corresponding to two heavy ions appears at higher energies. When it is so, the multichannel dynamical symmetries [5]* may enable us to describe the high-lying spectrum of resonances together with the low-energy part.

In Ref. [5] we have found that a reasonably good description of the ^{28}Si energy spectrum can be given in terms of the two-channel ^{24}Mg+α and ^{12}C+^{16}O dynamical symmetry, covering both the ground-state-region of well-defined band structure, and the ^{12}C+^{16}O resonances at the $E_x = 24 - 46MeV$ energies.

In the example of the ^{24}Mg we also address the question if the $B(E2)$ values can be obtained in terms of the ^{12}C+^{12}C and ^{20}Ne+α clusterizations simultaneously. Another interesting problem is the description of the rich ^{28}Si+α resonance spectrum [6] together with the low-lying ^{32}S states and the highly excited ^{16}O+^{16}O resonances. Work along this line is in progress.

This work was supported by the OTKA (No. T14321.) and by the U.S. - Hungarian Joint Fund (JF No. 345/93).

[1.] J. Cseh, G. Lévai and W. Scheid: Phys. Rev **C48** (1993) 1724
[2.] J. Cseh: Phys. Lett. **281B** (1992) 173
[3.] J. Cseh and G. Lévai: Ann. Phys. (N.Y.) **230** (1994) 165
[4.] J. Cseh: J. Phys. **G19** (1993) L97
[5.] J. Cseh: Phys. Rev. **C50** (1994) 2240
* see also the previous contribution to this volume
[6.] M. Brenner, private communication

Symmetry breaking in the Semimicroscopic Algebraic Cluster Model

G. Lévai, K. F. Pál and J. Cseh

The first applications of the Semimicroscopic Algebraic Cluster Model (SACM) [1] have shown that this model is able to give satisfactory description of a large amount of spectroscopic data on clustering phenomena of certain *sd*–shell nuclei [2]. These calculations had been performed in the $SU(3)$ dynamical symmetry limit, which allowed analytical determination of the energy spectrum. Our results were found to be in good agreement with experimental data (energy spectrum, $B(E2)$ values, etc.) indicating that the $SU(3)$ dynamical symmetry approach is a realistic approximation here [2].

A possible generalisation of the SACM is breaking the $SU(3)$ dynamical symmetry by introducing further terms in the Hamiltonian. This implies somewhat more involved calculations (i.e. diagonalisation of the Hamiltonian matrix), but it has advantages as well. Besides resulting a more realistic energy spectrum this approach also lifts the occasionally too restrictive selection rules implied by the dynamical symmetry. In addition, it also offers a convenient way of reducing the number of model parameters and of establishing a more natural link between the energy spectrum and electromagnetic transtion rates.

As the first application of this extended model we considered the spectroscopy of the ^{16}O nucleus in terms of a $^{12}C + \alpha$ cluster picture. The symmetry–breaking interaction term we included was the $C_2(SO_R(4)) \equiv D^{(1)} \cdot D^{(1)}$ operator, which is the square of the electric dipole operator associated with the relative motion of the clusters. It is widely used in molecular physical applications of the Vibron Model [3], and it is known to couple different $U_R(3)$ representations associated with different nuclear shells in nuclear physical applications. We added this term to a five–parameter symmetry–conserving Hamiltonian and varied its strength in order to study the behaviour of the resulting theoretical energy spectrum and electromagnetic transition rates. The best fit to experimental data was found for a weak breaking of the $SU(3)$ symmetry.

This extension of the SACM represents a step towards its standardisation, i.e. towards a Hamiltonian of a standard form, which can be used in systematic applications of the model to a wide range of nuclei.

This work was supported by the OTKA (No. T14321.) and by the U.S.–Hungarian Joint Fund (JF No. 345/93).

1. J. Cseh and G. Lévai: Ann. Phys. (N. Y.), **230** (1994) 165.
2. G. Lévai, J. Cseh and W. Scheid: Phys. Rev. C **46** (1992) 548.
   J. Cseh, G. Lévai and W. Scheid: Phys. Rev. C **48** (1993) 1724.
3. F. Iachello and R. D. Levine: "Algebraic Theory of Molecules", Oxford Univ. Press, Oxford, U.K., 1993.

Structure of ^{70}As nucleus

Zs. Podolyák and T. Fényes

In our earlier work we have measured the γ–ray, $\gamma\gamma$–coincidence, internal conversion electron and γ–ray angular distribution spectra of the ^{70}Ge(p,nγ)^{70}As reaction and deduced a new level scheme of ^{70}As, spin–parity values, γ –branching and mixing ratios [1,2].

In the present work the energy spectra and electromagnetic moments of ^{70}As (and neighbouring ^{68}Ge and ^{69}Ge) nuclei were calculated in the framework of the interacting boson(–fermion–fermion) model [IB(FF)M] / truncated quadrupole phonon model (for odd–odd nuclei). Reasonable agreement has been obtained between experimental and theoretical results. The experimental and IB(FF)M level schemes are compared in Figs. 1 and 2.

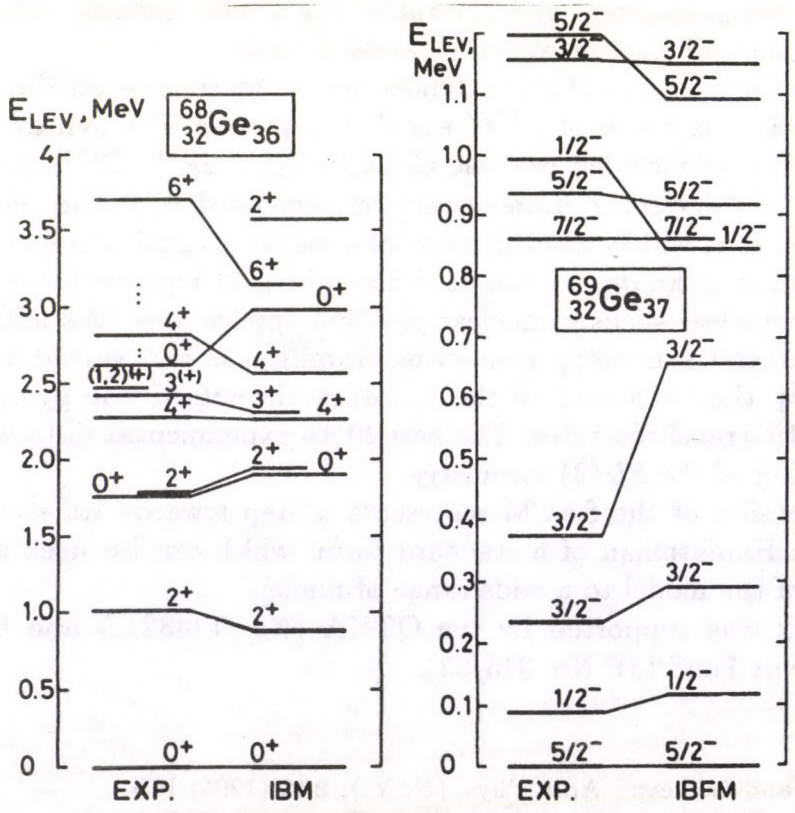


Fig. 1. Low-lying experimental positive parity levels of ^{68}Ge [3] and negative parity levels of ^{69}Ge [4] in comparison with IBM and IBFM theoretical results.

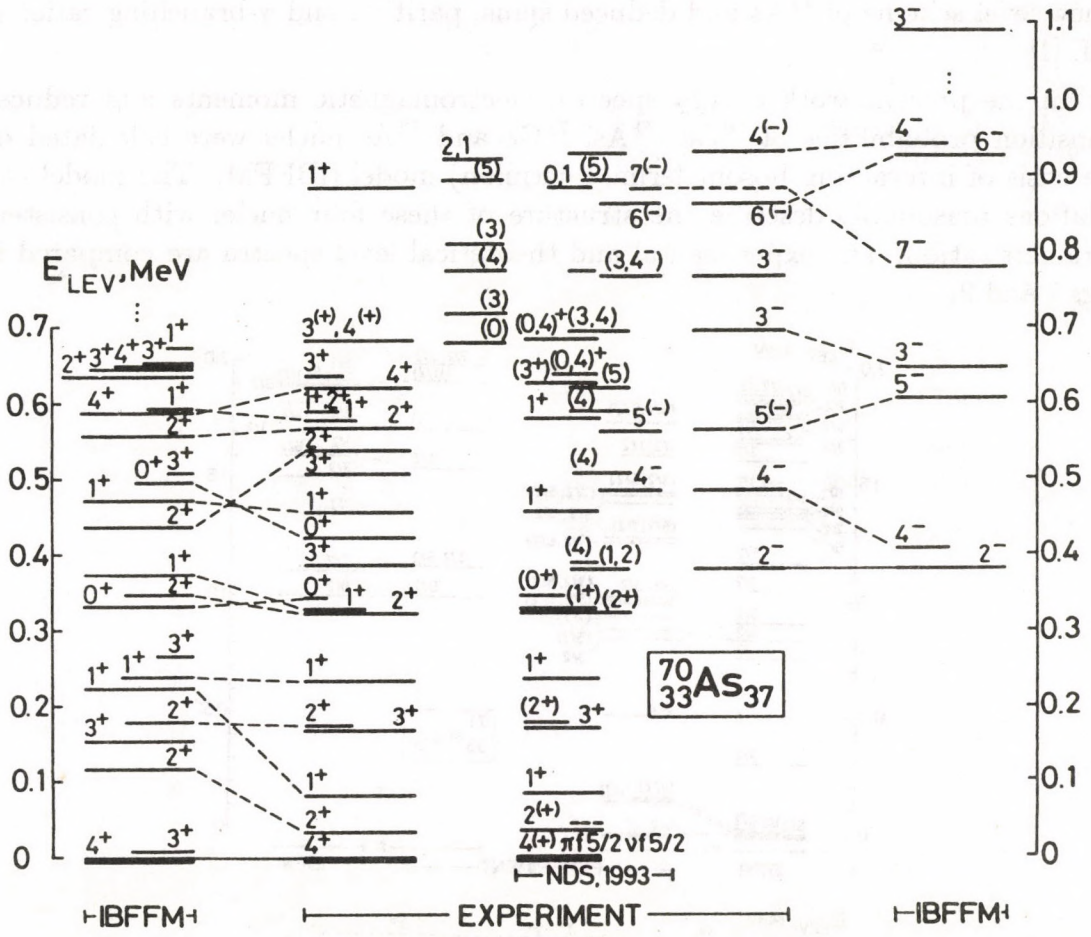


Fig. 2. Experimental and IBFFM theoretical energy spectra of ^{70}As for positive and negative parity levels separately. NDS, 1993 is a reference on [5].

This work was supported by the OTKA Foundation (grant No. 3004).

References

1. Zs. Podolyák, J. Timár and T. X. Quang, ATOMKI Ann. Rep. 1992, p. 16.
2. Zs. Podolyák and T. Fényes, ATOMKI Ann. Rep. 1993, p. 12.
3. M. R. Bhat, Nucl. Data Sheets **55** (1988) 1.
4. M. R. Bhat, Nucl. Data Sheets **58** (1989) 1.
5. M. R. Bhat, Nucl. Data Sheets **68** (1993) 117.

Consistent description of the structure of ^{70}Ge, ^{71}As, ^{71}Ge and ^{72}As nuclei

D. Sohler, T. Fényes, S. Brant†, V. Paar† and Lj. Šimičić†

†Dept. of Phys., Faculty of Science, University of Zagreb, 41000 Zagreb, Croatia

Based on our earlier in-beam γ-spectroscopic measurements, we have proposed a new level scheme of ^{72}As and deduced spins, parities, and γ-branching ratios in Ref. [1].

In the present work energy spectra, electromagnetic moments and reduced transition probabilities of ^{70}Ge, ^{71}As, ^{71}Ge and ^{72}As nuclei were calculated on the basis of interacting boson(-fermion-fermion) model [IBFFM]. The model calculations reasonably describe the structure of these four nuclei with consistent parametrization. The experimental and theoretical level spectra are compared in Figs.1 and 2.

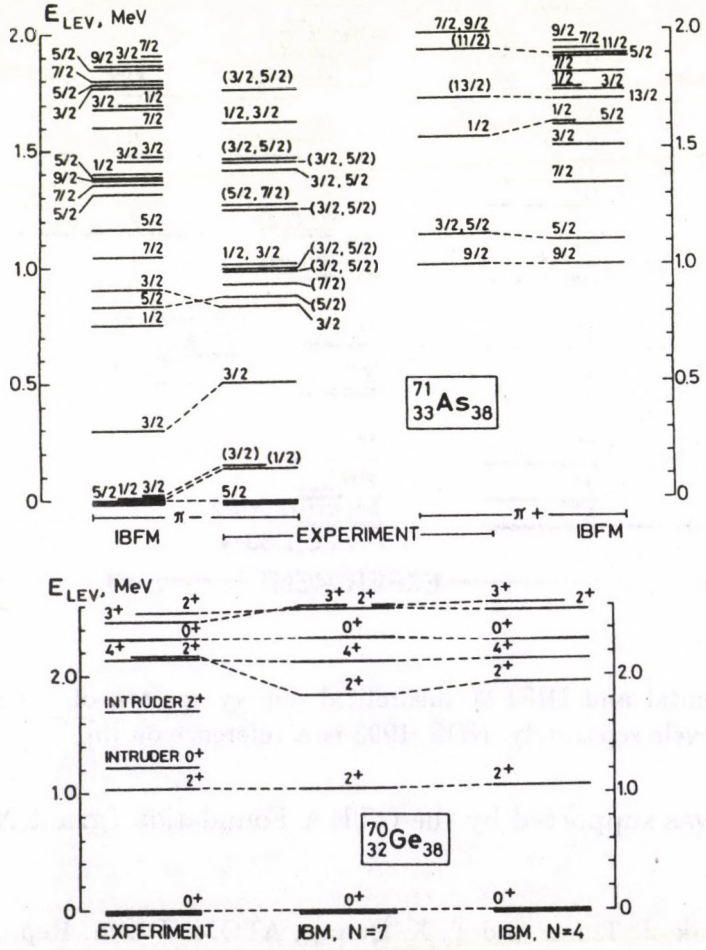


Fig. 1. Experimental energy spectra of ^{70}Ge [2] and ^{71}As [3], and the corresponding theoretical IBM and IBFM results. $\pi+$ and $\pi-$ mean positive and negative parity states, respectively.

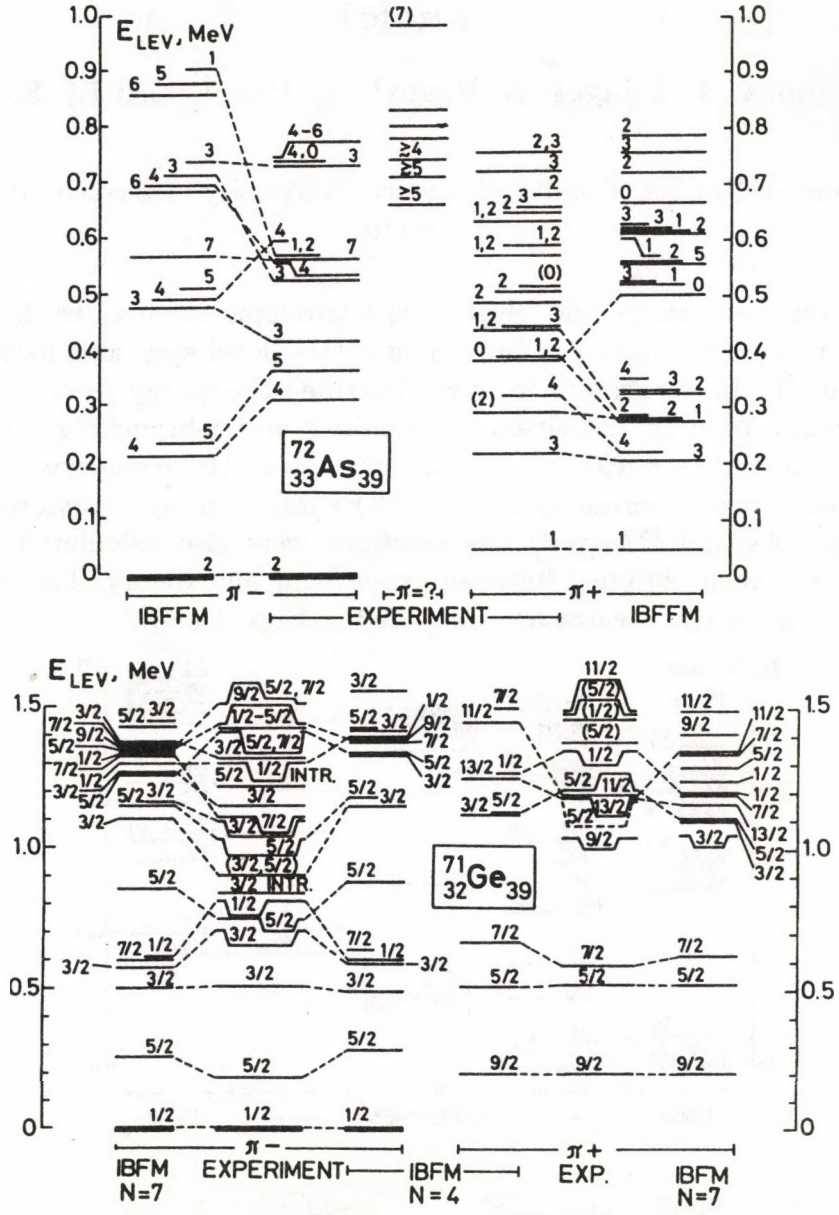


Fig. 2. Experimental energy spectra of ^{71}Ge [3] and ^{72}As, and the corresponding theoretical IBFM and IBFFM results.

This work was supported by the OTKA Foundation (grant No. 3004).

References

1. D. Sohler and T. Fényes, ATOMKI Ann. Rep. 1993, p. 14.
2. M. R. Bhat, Nucl. Data Sheets **68** (1993) 117.
3. M. R. Bhat, Nucl. Data Sheets **68** (1993) 579.

Structure of ^{72}Ge, ^{73}As, ^{73}Ge, and ^{74}As nuclei

A. Algora, T. Fényes, S. Brant†, V. Paar†, and Lj. Šimičić†

†Department of Physics, Faculty of Science, University of Zagreb, 41000 Zagreb, Croatia

Based on in-beam γ- and electron-spectroscopic studies, we have formerly deduced a new level scheme, γ-branching ratios, level spin and parity values of ^{74}As nucleus [1]. In the present work we describe the energy spectra, electromagnetic moments, reduced transition probabilities and γ-branching ratios of ^{72}Ge, ^{73}As, ^{73}Ge, and ^{74}As nuclei in a consistent way in the framework of the interacting boson(-fermion-fermion) model [IB(FF)M]. The spectroscopic factors of ^{73}Ge(^{3}He,d)^{74}As and ^{75}As(p,d)^{74}As reactions were also calculated. Reasonable agreement has been obtained between experiment and theory. The experimental and theoretical energy spectra are compared in Figs. 1 and 2.

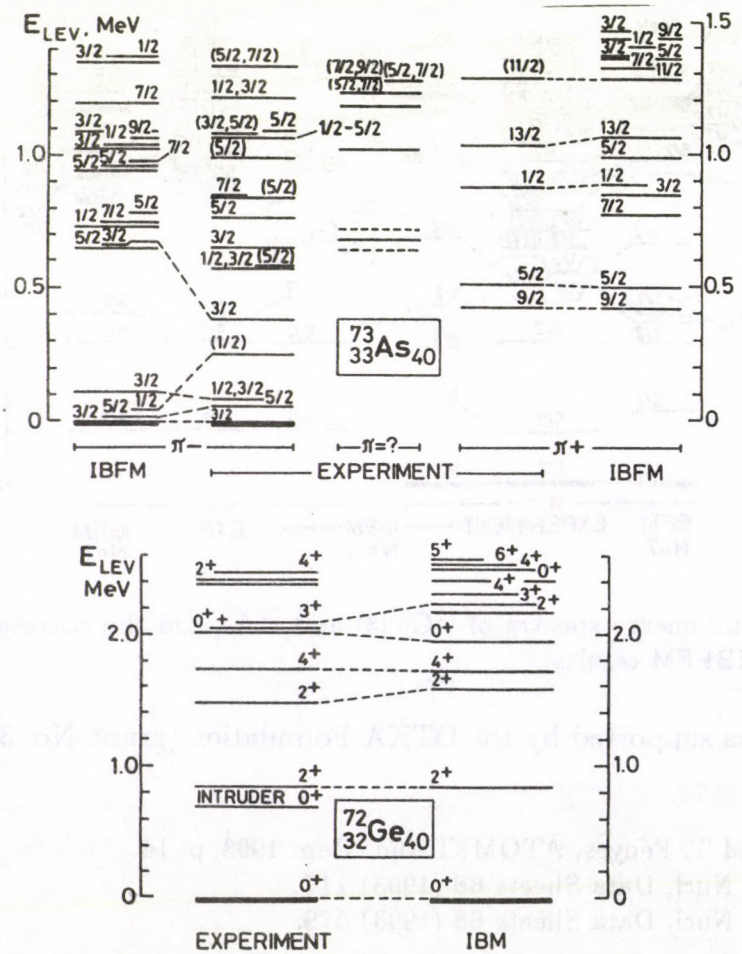


Fig. 1. Experimental energy spectra of ^{72}Ge [2] and ^{73}As [3] and the corresponding theoretical IBM and IBFM results.

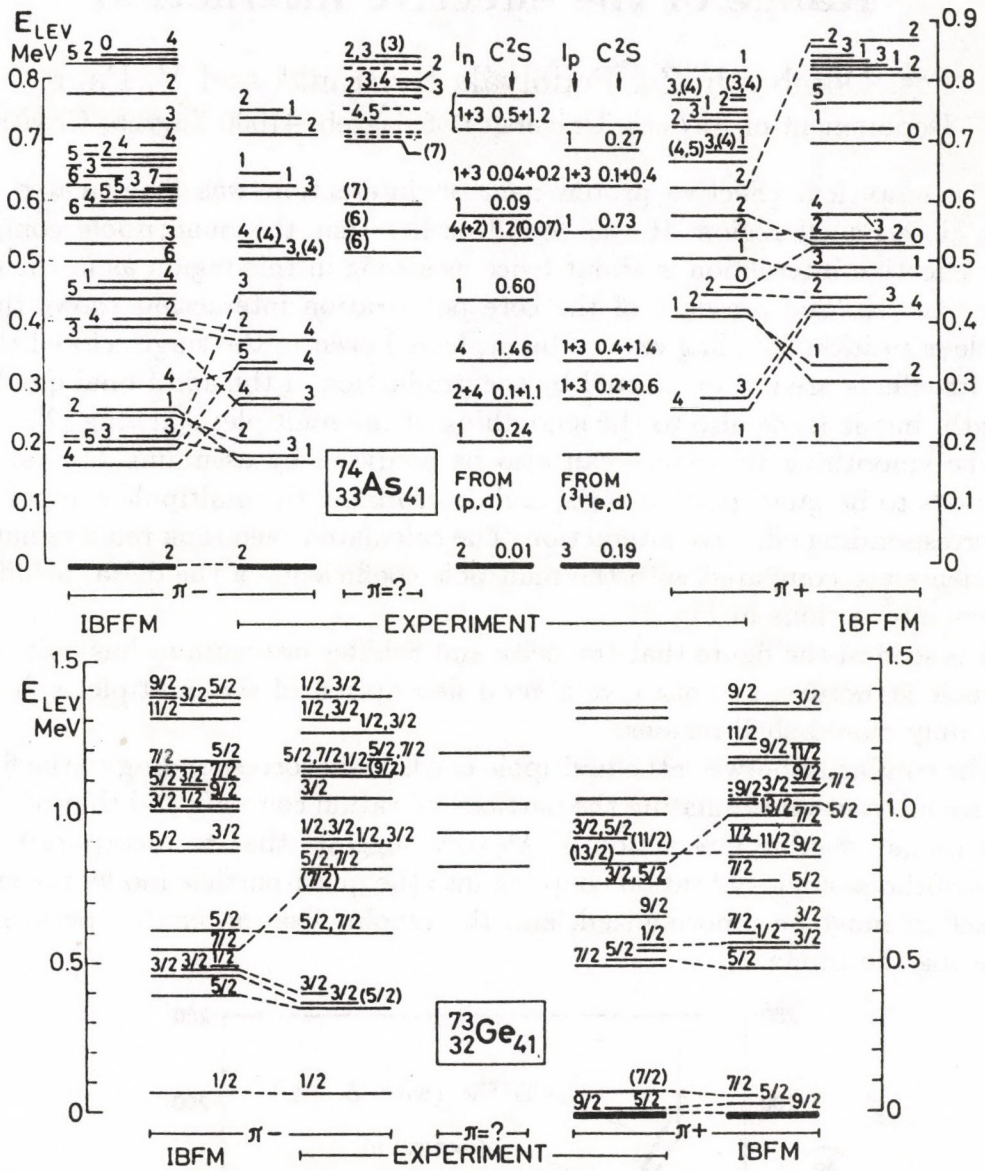


Fig. 2. Experimental energy spectra of ^{73}Ge [3] and ^{74}As in comparison with IBFM and IBFFM theoretical results. The (p,d) and (^{3}He,d) data were taken from [4] and [5], respectively.

This work was supported by the OTKA Foundation (grant No. 3004).

References

1. A. Algora and T. Fényes, ATOMKI Ann. Rep. 1993, p. 16.
2. M. M. King, Nucl. Data Sheets **56** (1976) 1.
3. M. M. King, W.-T. Chou, Nucl. Data Sheets **68** (1993) 857; and D. Sohler, Zs. Podolyák private communication.
4. R. Fournier et al., Nucl. Phys. **A188** (1972) 632.
5. B. Rosner et al. Nucl. Phys. **A206** (1973) 76.

Range of the effective interaction

Zs. Dombrádi, Zs. Podolyák, S. Brant[+] and V. Paar[+]
[+] Department of Physics, University of Zagreb, 41000 Zagreb, Croatia

The empirical effective proton–neutron interaction was investigated in the singly closed shell region. It was found earlier that the quadrupole component of the effective interaction is about twice as strong in this region as in the doubly magic one [1]. The presence of the core polarization interaction shows that the particle–vibration coupling cannot be neglected even in the singly closed shell region. Its effects are not exhausted by the production of the additional quadrupole strength, but it leads also to the smoothing of the multiplet splitting [2].

The smoothing procedure can also be analysed by assuming the calculated multiplets to be quasi-particle ones, and determining the multipole components of the corresponding effective interaction. The calculated even rank relative multipole coefficients are compared with the multipole coefficients of the delta, Schiffer and Alexeev interactions in Fig. 1.

It is seen in the figure that the delta and Schiffer interactions has quite similar multipole structure, as both give a good description of the multiplet splitting in the doubly closed shell regions.

The similarity between the multipole coefficients corresponding to the fictional effective interaction simulating the particle–vibration coupling and that of the long (2fm) range effective interaction of Alexeev suggests that to incorporate all the effects of the particle–vibration coupling into the quasi-particle model the effective interaction must be renormalized, and the renolmalization can be performed by increasing the range.

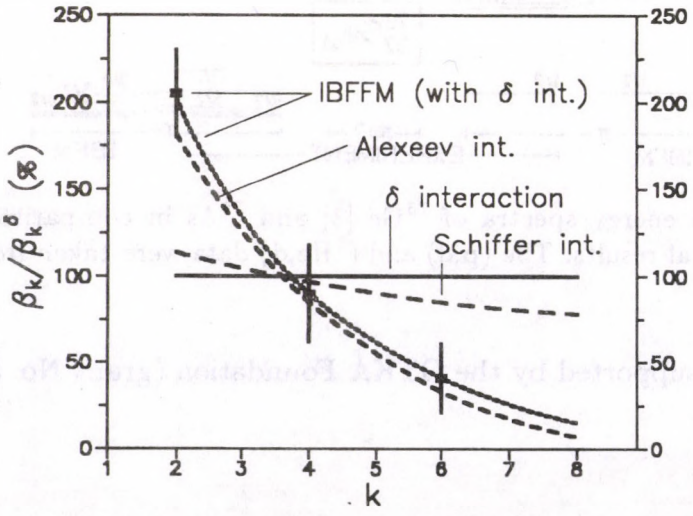


Fig. 1. Comparison of the even multipole coefficients of different effective proton-neutron interactions with the multipole coefficients of the interaction simulating the IBFFM.

[1] Zs. Dombrádi, S. Brant, and V. Paar, Mod. Phys. Lett. **A7**, 271 (1992).
[2] Zs. Dombrádi, S. Brant, and V. Paar, Phys. Rev. C **47** (1993) 1539.

Redistribution of valence neutrons in ^{122}Sb

Zs. Dombrádi, D. Sohler, S. Brant+ and V. Paar+

+ Department of Physics, University of Zagreb, 41000 Zagreb, Croatia

Federman and Pittel predicted that, as a result of the proton-neutron correlation, when protons start to occupy an orbit, they pull valence neutrons onto the strongly overlapping orbitals, too, which results in rearrangement of the valence neutrons [1].

We have shown that the splitting of the proton–neutron multiplets is very sensitive to the occupation probabilities. To search for the above effect the experimental data on odd-odd Sb nuclei were analysed using the interacting boson-fermion-fermion model.

We have fitted the occupation probability of the neutron states having the proton either in $d_{5/2}$ or in $g_{7/2}$ state, while fixing all the other parameters of the IBFFM at some reasonable value. The results of the fitting are shown in Fig. 1. for the case of ^{122}Sb. It is clearly seen that when the proton is in $d_{5/2}$ state, then the occupation of the $\nu d_{3/2}$ state gets larger, and when the proton is in $g_{7/2}$ state, the $\nu h_{11/2}$ state, overlapping more with the $g_{7/2}$ state, gets more occupied. The latter situation was observed also in ^{120}Sb and ^{124}Sb nuclei. The difference in the occupation probabilities was $\Delta v^2_{\nu h_{11/2}} \approx 0.08$ in those cases, too. Half of the changes in the occupation probabilities arose from the monopole proton-neutron interaction, the other half could be interpreted as the effect of the core polarization.

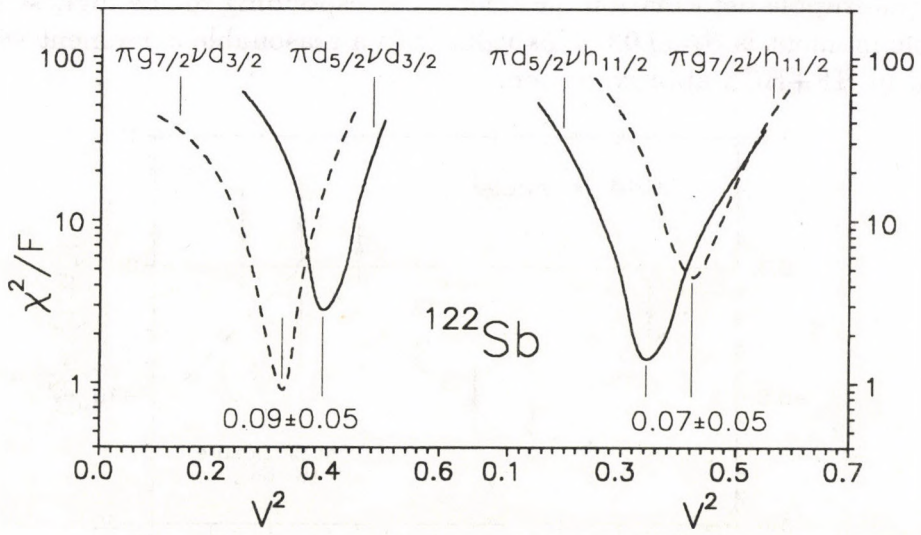


Fig. 1. IBFFM fit to the splitting of $\pi d_{5/2}\nu h_{11/2}$, $\pi g_{7/2}\nu h_{11/2}$ and $\pi d_{5/2}\nu d_{3/2}$, $\pi g_{7/2}\nu d_{3/2}$ multiplets of ^{122}Sb as a function of the neutron occupation probabilities.

[1] F. Federman and S. Pittel, Phys. Rev. C **20** (1978) 820.

Microdeformation in odd In nuclei

Zs. Dombrádi, D. Sohler, S. Brant+ and V. Paar+

+ Department of Physics, University of Zagreb, 41000 Zagreb, Croatia

In principle, even a single nucleon is able to deform the nucleus to some extent, by polarizing the cloud of the valence nucleons. If a proton is added outside the closed shell, the valence neutron distribution is expected to be slightly modified to achieve better overlap with the proton orbit, and in this way some finite intrinsic quadrupole moment can be generated. According to the Le Châtelier–Brown principle, the external quadrupole field of the odd particle, will shift the equilibrium quadrupole moment of the core in that direction, where the external field is weakened. For example in odd In nuclei the $g_{9/2}$ hole has a positive quadrupole moment, so it is expected to generate some negative quadrupole moment. The magnitude of the induced quadrupole moment should increase linaerly from A=100 to A=107, followed by a decrease from A=107 to A=114 on the basis of the N_pN_n scheme, taking into account the subshell closure at N=64.

To analyse the quadrupole moment of the core in $^{103-117}$In nuclei, we fitted the parameters of the particle-vibration interaction to the splitting of the one-phonon multiplet of the $g_{9/2}$ proton state using IBFM approximation. We found that all the parameters of the particle–vibration interaction are nearly constant over the investigated mass region, except χ, characteristic for the static part of the quadrupole moment of the phonon. The values obtained for χ are shown in Fig. 1.

The quadrupole deformation parameter coreesponding to the highest induced quadrupole moment is $\beta_2 \approx 0.03$. This value is in a reasonable agreement with that calculated in HF+BCS approximation.

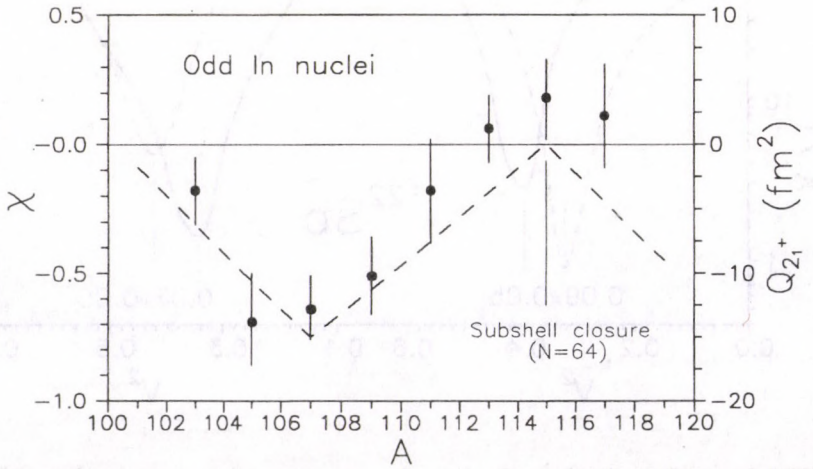


Fig. 1. Mass number dependence of the χ parameter of IBFM, fitted to the splitting of the one-phonon multiplet of $^{103-117}$In. The dashed line is proportional to N_pN_n, where N_p=1, and N_n is the number of the valence neutrons between two subshell closures.

Mean field analysis of the p-n asymmetry in ^{150}Nd

Zs. Dombrádi, D. Sohler and A. Krasznahorkay

The difference of the nuclear and charge quadrupole deformations in ^{150}Nd was measured at the Institute [1]. To get a deeper insight into the reasons of the above difference we calculated the ground state properties of the ^{150}Nd in Hartree–Fock + BCS approximation using Skyrme III nucleon–nucleon interaction.

The binding energy calculations were performed in a wide range of the quadrupole moment applying a quadratic constraint to the mass quadrupole moment. The minimum of the potential energy surface was found at Q_m=1255 fm^2 and γ=0°. The charge radius and quadrupole moment at this deformation are in good agreement with corresponding experimental values.

To compare with the experimental data, the quadrupole deformation parameters were deduced assuming homogeneous proton and neutron distributions with sharp surfaces. Their ratio, β_2^n/β_2^p=0.94 is in reasonable agreement with the experimental result 0.93±0.03 [1].

In addition to the deformation parameters, the proton and neutron densities can also be determined from the HFB wave functions. The difference of the density distributions normalized to the same volume was calculated to search for the origin of the difference in deformations. The results are shown in Fig. 1. It is seen that proton excess (white in Fig. 1) is concentrated along the prolate direction, but not at the end of distribution as the naive model used for the experimental data analysis suggests. An other difference is that the values of the proton and neutron excesses are only few percents of the average densities.

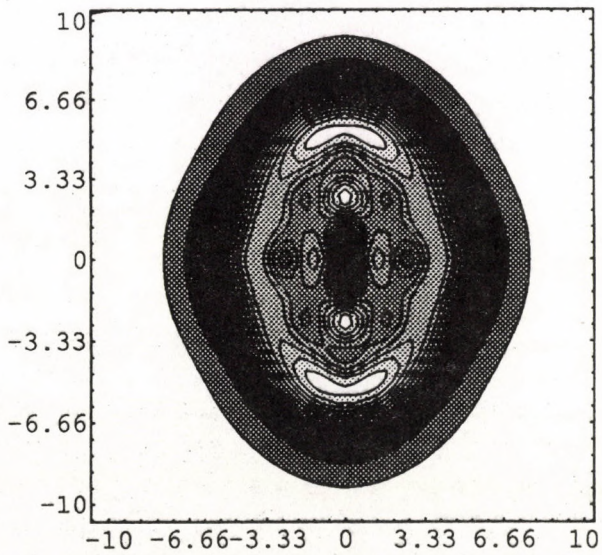


Fig. 1. Difference of the normalized proton and neutron distributions in topographic representation. The contour level difference is 0.002 nucleon/fm^3.

[1] A. Krasznahorkay, M. Csatlós, Z. Máté and A. T. Kruppa, ATOMKI Ann. Rep. 1993, p.28.

ATOMIC PHYSICS

Compilation of the $K\beta_5/K\alpha_1$ x-ray intensity ratios

I. Török, T. Papp, J. Pálinkás, M. Budnar[1], A. Mühleisen[1], J. Kawai[2], J. L. Campbell[3].

[1] Jozef Stefan Institute, Ljubljana, Slovenia. [2] Dept. of Materials Science and Eng., Kyoto University, Kyoto, Japan. [3] Guelph University, Dept. of Physics, Guelph, Canada

The low intensity $K\beta_5$ line in the K x-ray spectrum is often regarded as a $K\text{-}M_{IV,V}$ transition. For freee atoms and for Z>30 elements the $K\beta_5$ line can be described as a quadrupole (E2) transition. For elements between Z values of 16 to 29 in solids or in compounds a significant dipole component may appear due to solid state or chemical effects. This causes an enhancement of the intensity of the $K\beta_5$ line and gives a peak at Z=24 (Cr) in the $K\beta_5/K\alpha_1$ relative intensity as a function of the atomic number. This enhancement is discussed theoretically in the book of Agarwal [1]. Experimental values of this enhanced intensity are given in e. g. the x-ray tables of Blokhin [2]. Many other tables, however give the values of Scofield [3] calculated for free atoms, and the difference can reach a factor of 70. We compiled experimental intensity values published [4] from the early thirties to 1994, and they are shown in fig. 1. as a function of the atomic number of the emitting atoms.

This work was supported by OTKA, grant No. 3011.

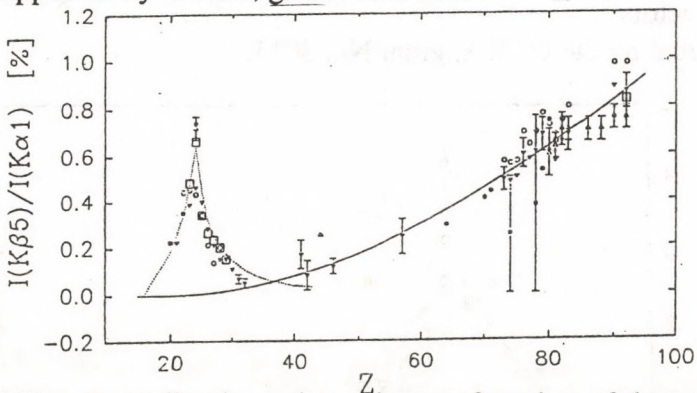


Fig. 1. The $K\beta_5/K\alpha_1$ x-ray line intensity ratio as a function of the atomic number of the emitting element. Symbols: experimental data of different origin (sources are given in ref. [4]), curves: theoretical values: full line: Scofield [3], dotted line: Agarwal [1].

[1] B. K. Agarwal: X-Ray Spectroscopy. An Introduction. Springer Series in Optical Scinces, Vol. 15, 1st ed. (Springer-Verlag, Berlin, Heidelberg, New York, 1979.) p.116.
[2] M. A. Blokhin, I. G. Svejcer: Rentgenospektralny spravochnik, (Nauka, Moscow, 1982),Table 12.1, p. 70. (In Russian.)
[3] J. H. Scofield, Phys. Rev. **179** (1969) 9; Atomic Data and Nuclear Data Tables **14** (1974) 121.
[4] I. Török, T. Papp, J. Pálinkás, M. Budnar, A. Mühleisen, J. Kawai, J. L. Campbell,On the relative intensity of the $K\beta_5$ x-ray line. In preparation.

The effect of the $K\beta_5$ x-ray line intensity in EDS PIXE measurements

I. Török, T. Papp, J. Pálinkás, M. Budnar[1], A. Mühleisen[1], J. Kawai[2], J. L. Campbell[3].

[1] Jozef Stefan Institute, Ljubljana, Slovenia. [2] Dept. of Materials Science and Eng., Kyoto University, Kyoto, Japan. [3] Guelph University, Dept. of Physics, Guelph, Canada

As it was discussed in the preceding paper of this Annual Report, the $K\beta_5$ line of $16<Z<29$ elements in solids and compounds can be considerably enhanced. The enhanced intensity of the $K\beta_5$ x-ray line can reach 4% relative to the $K\beta_{1,3}$ line (Fig. 1.), and one has to consider this enhancement in the energy dispersive X-ray spectrometry. If the K x-ray spectra are fitted with two peaks, only a modest fit can be obtained. Using additional peaks of relative intesities of a few percent, at the energies where the low intensity $K\beta_5$ or radiative Auger emissions should appear, the fit can be considerably improved. For better PIXE analytical results it seems to be important to measure the $K\beta$ region with crystal spectrometers, and determine the accurate energies and intensities of the low energy components. These values can be used in the evaluation of x-ray spectra obtained by semiconductor detectors.

This work was supported by the OTKA, grant No. 3011.

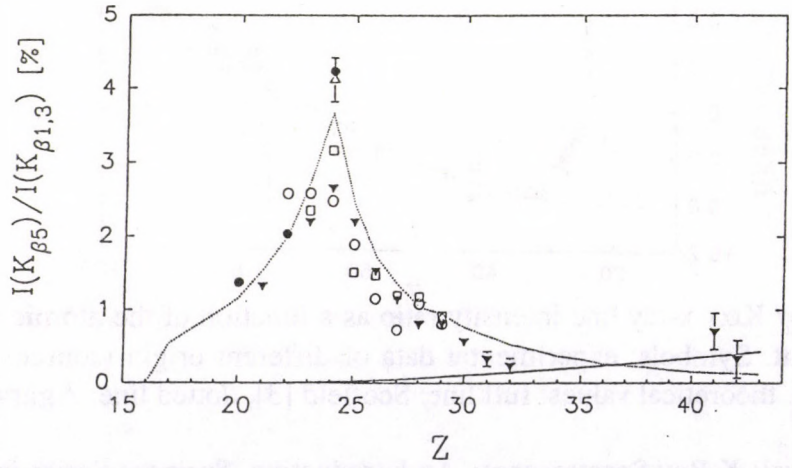


Fig. 1. The $K\beta_5/K\beta_{1,3}$ x-ray intensity ratio as a function of the atomic number of the emitting element. Symbols represent experimental data of different origin, curves represent theoretical values by Agarwal [1] dotted line, and by Scofield [2] full line.

[1] B. K. Agarwal: X-Ray Spectroscopy. An Introduction. Springer Series in Optical Scinces, Vol. 15, 1st ed. (Springer-Verlag, Berlin, Heidelberg, New York, 1979.) p.116.
[2] J. H. Scofield, Phys. Rev. **179** (1969) 9; Atomic Data and Nuclear Data Tables **14** (1974) 121.

Measurement of the Kβ x-ray lines of Ca, Ti, Cr, and Fe simultaneously with EDS and WDS methods

I. Török, T. Papp, J. Pálinkás, M. Budnar[1], A. Mühleisen[1], J. Kawai[2], J. L. Campbell[3].

[1] Jozef Stefan Institute, Ljubljana, Slovenia. [2] Dept. of Materials Science and Eng., Kyoto University, Kyoto, Japan. [3] Guelph University, Dept. of Physics, Guelph, Canada

In the two preceding papers of this Annual Report and in [1], we discussed some properties of the $K\beta_5$ x-ray line from the point of view of solid state and chemical effects and those of PIXE analysis. It turns out that the experimental values for the intensity of the $K\beta_5$ line, and those for the Radiative Auger Emission lines for medium Z elements are rather uncertain in the literature. Therefore we measured the Kβ spectra of Ca, Ti, Cr, and Fe. The measurements were performed in Ljubljana, using a Van de Graaff generator to excite the metallic samples by 1.2 MeV protons. A flat crystal spectrometer equipped with PSD was used to get high resolution spectra. With this set up good quality spectra (Fig. 1.) could be obtained despite the low intensity of the $K\beta_5$ line. The target was seen also by a Si(Li) detector simultaneously. The evaluation of the high resolution and semiconductor detector spectra is in process.

This work was supported by the OTKA, grant No. 3011.

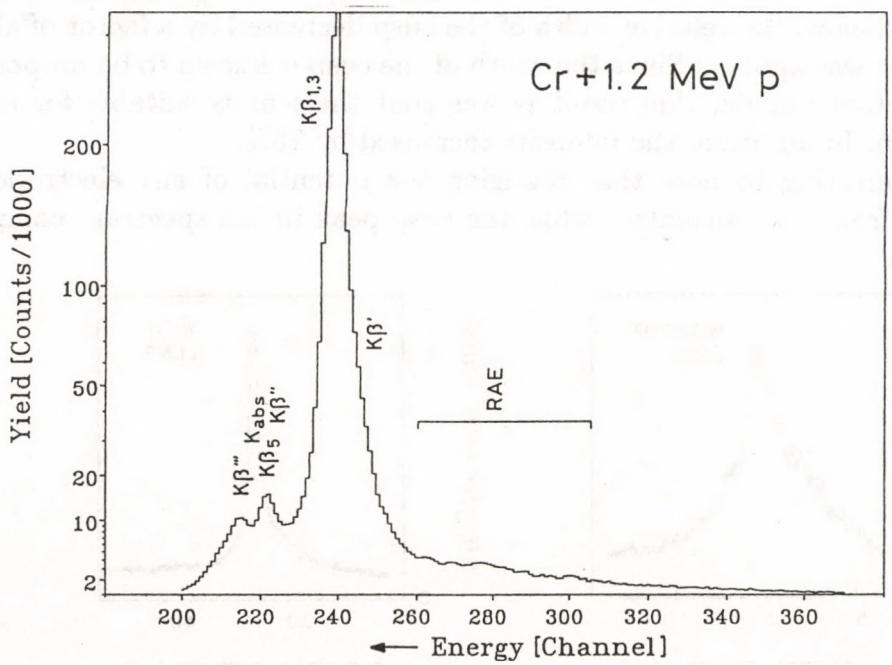


Fig. 1. The spectrum of the Cr Kβ x-ray lines.

[1] I. Török, T. Papp, J. Pálinkás, M. Budnar, A. Mühleisen, J. Kawai, J. L. Campbell, On the relative intensity of the $K\beta_5$ x-ray line. In preparation.

A New Electrostatic Lens for Zero-Degree Electron Spectroscopy

L. Víkor [$] , L. Sarkadi, K. Tőkési, D. Varga, A. Báder,
F. Penent [†] and J. Pálinkás

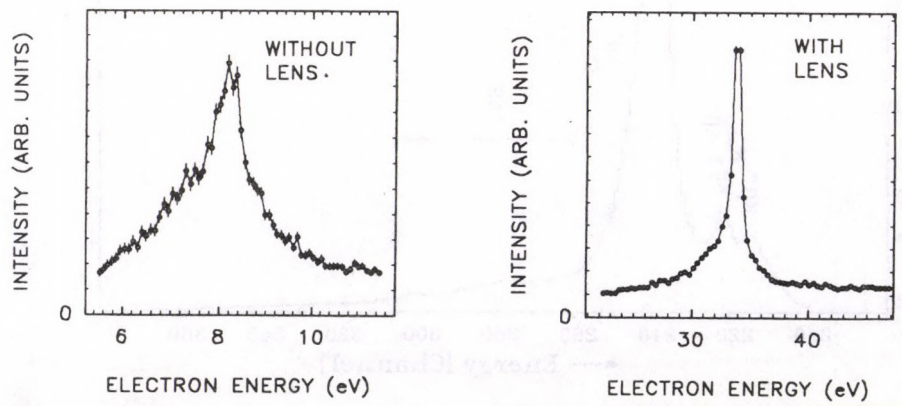
To improve our electron analysis at zero degree [1] we constructed an electrostatic lens with the primary aim to extend our studies to lower energies and smaller acceptance angles.

The lens was placed in front of the spectrometer entrance. The gas target was moved from the object point of the spectrometer ('old target' position) to the object point of the lens ('new target' position). The lens consists of six cylindrically symmetric electrodes: four cylinders and two disks. One of the cylinders consists of four isolated parts, and besides its main role it serves as two pairs of deflection plates to correct misalignment between the lens axis and the spectrometer axis.

The first test of the lens was made for the electron transport from the new target position to the old one without acceleration and angular magnification. Measuring the cusp peak from 500 keV C^+ on He collisions with and without the lens we have got similar results.

The next test was the measurement of the cusp at 200 keV with and without lens. For this projectile energy the cusp energy is only 8 eV. The lens was operated with a condition of acceleration four and a large angular magnification. As is seen in the figure below, the relative width of the cusp decreased by a factor of about 5 when the lens was applied. Since the width of the cusp is known to be proportional to the acceptance angle, this result proves that the lens is suitable for angular magnification. In addition, the intensity increased by 75%.

It is interesting to note that changing the potential of any electrode by a few percent from the calculated value, the cusp peak in the spectrum completely disappeared.



[†] L.D.M.A., Université Paris 6, Paris Cedex 05, France
[$] Permanent address: Institute of Physics, Belgrade, Yugoslavia

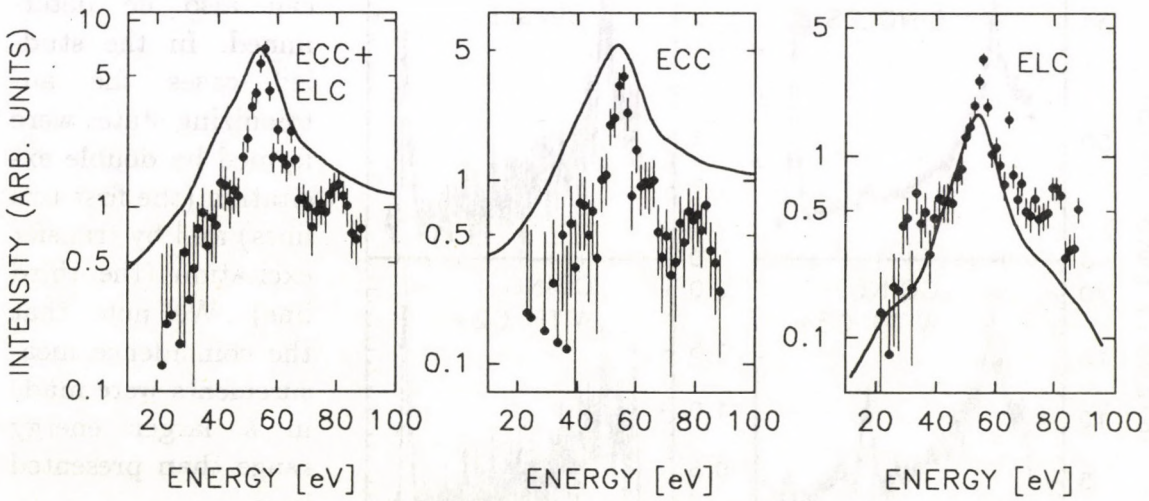
1. Á. Kövér *et al.*: J. Phys. B **22** 1595 (1989)

Study of Cusp Electron Production at Impact C^+ Ions

L. Víkor [$], L. Sarkadi, A. Báder, F. Penent [†], J. Pálinkás and D. Berényi

After systematic investigations of the forward cusp with H and He (atoms and ions) we are continuing with heavier projectiles. For the collisions of 40 keV/u and 100 keV/u impact energy C^+ ions with He target we used coincidence technique to determine the relative contributions of the ECC (*electron capture to the continuum*) and ELC (*electron loss to the continuum*) processes to the cusp. According to existing theoretical (*Classical Trajectory Monte Carlo*) results for this collision system [1], at 100 keV/u the cross section for ELC is more than three times smaller than that for ECC. From the preliminary data evaluation we have got that the intensities of the two processes are almost the same for that energy, and even at 40 keV/u ELC is only 1.5 times smaller than ECC. In the figure below are shown experimental (points with error bars) and theoretical (full curve) data. The theoretical and experimental spectra were normalized at the maxima of the total (ECC + ELC) cusp.

The question arises: is the model used for the calculations not precise enough, or other processes with the same final states also contribute to the cusp and are not considered by the theory (e.g., unresolved autoionization lines in the ELC channel)?



† L.D.M.A., Université Paris 6, Paris Cedex 05, France
$ Permanent address: Institute of Physics, Belgrade, Yugoslavia

1. C. O. Reinhold *et al.*: J. Phys. B: At. Mol. Opt. Phys. **23** L297 (1990)

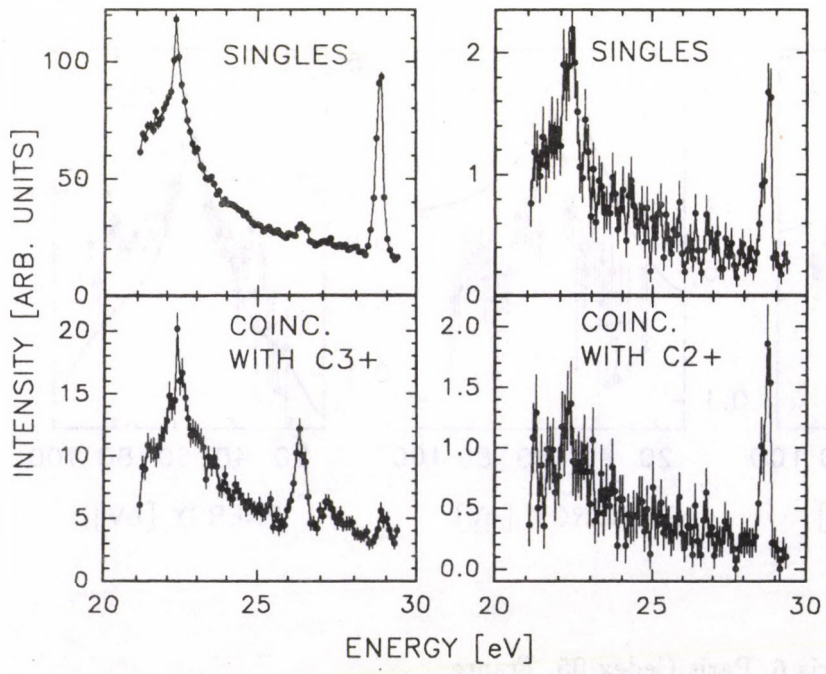
Determination of the Final Ion State of Autoionization Transitions Excited in C^+ and C^{2+} on He Collisions

L. Víkor [$], L. Sarkadi, A. Báder, F. Penent [†], J. Pálinkás and D. Berényi

Generally, the method of zero-degree electron spectroscopy [1] does not use the coincidence technique to define the final charge state of the outgoing projectile. In the present work we measured the autoionization lines of carbon from collisions of 0.5 MeV C^{2+} and 1.2 MeV C^+ with He in coincidence with the outgoing charge-state analyzed ions.

In the figure below are presented electron spectra in the cusp region for 0.5 MeV C^{2+} impact. The first broad peak from the left is the cusp, and the next three peaks at 26.3, 27.2 and 28.9 eV are from autoionization (Auger) transitions. In the spectrum transformed to the projectile frame the three lines appear at energies 0.16, 0.22 and 0.39 eV. For coincident detection of electrons with C^{3+} ions the lines at 26.3 and 27.2 eV, which are even hard to see in the 'singles' spectrum, are pronounced in the coincidence spectrum. In the same spectrum the line at 28.9 eV disappears (within error). On the other hand, the latter line shows 100% correlation with C^{2+}.

With the information for the initial and final charge state of the projectile the excitation mechanism can also be determined. In the studied cases the autoionizing states were formed by double excitation (the first two lines) and by transfer excitation (the third line). We note that the coincidence measurements were made in a larger energy range than presented here.



† L.D.M.A., Université Paris 6, Paris Cedex 05, France
$ Permanent address: Institute of Physics, Belgrade, Yugoslavia

1. N. Stolterfoht: Phys. Rep. **146** 317 (1987)

Cusp-Electron Production in 0.5–1.5 MeV/u O^{7+} + Ar Collisions

M. Zhu †, R. R. Haar †, S. M. Ferguson †, O. Woitke †, J. A. Tanis †, L. Sarkadi, J. Pálinkás, P. A. Závodszky and D. Berényi

In the present work cusp-electron production has been investigated for intermediate-energy (0.5–1.5 MeV/u) O^{7+} + Ar collisions. For this system, cusp electrons can result from *electron capture to the continuum* (ECC), *electron loss to the continuum* (ELC), *transfer ionization* (TI) and *double transfer ionization* (2TI). Of particular interest are the ratios TI/ECC and 2TI/ECC, which represent the probabilities for cusp-electron production as part of two- and three-electron processes, respectively, compared to the single-electron process, ECC. These ratios may provide information on the role of the electron–electron interaction in forward-electron emission.

This work was done at Western Michigan University using the 6 MeV EN tandem Van de Graaff accelerator. Electrons emitted along the beam direction were energy analyzed with a tandem-parallel-plate electron spectrometer and detected with a channel-electron multiplier. The ions in the outgoing beam were magnetically analyzed to separate the various charge-state components and were counted with silicon surface-barrier detectors. The ECC, ELC, TI and 2TI reaction channels were identified by detecting electrons in coincidence with O^{7+}, O^{8+}, O^{6+} and O^{5+}, respectively.

We found that for all energies investigated, significant contributions to the cusp come from ECC, ELC, TI, and 2TI. This is contrary to the low-energy results [1] for O^{q+} and the intermediate-energy results [2] for H^+ and He^+, for which cusp production is dominated by one process. The TI/ECC and 2TI/ECC ratios obtained each exhibit a maximum near 0.75 MeV/u, reaching values of about 0.9 and 0.3, respectively; the ELC/ECC ratio, on the other hand, increases monotonically with beam energy from a value of about 0.01 at 0.5 MeV/u to about 0.1 at 1.5 MeV/u.

The high probabilities observed for cusp-electron production with simultaneous single- or double- bound-state capture indicate a significant contribution from the electron-electron interaction in this process, although the extent of this contribution needs to be quantified. Also, the origin of the observed maximum in the TI/ECC and 2TI/ECC ratios needs to be determined.

† Western Michigan University, Kalamazoo, Michigan 49008, USA

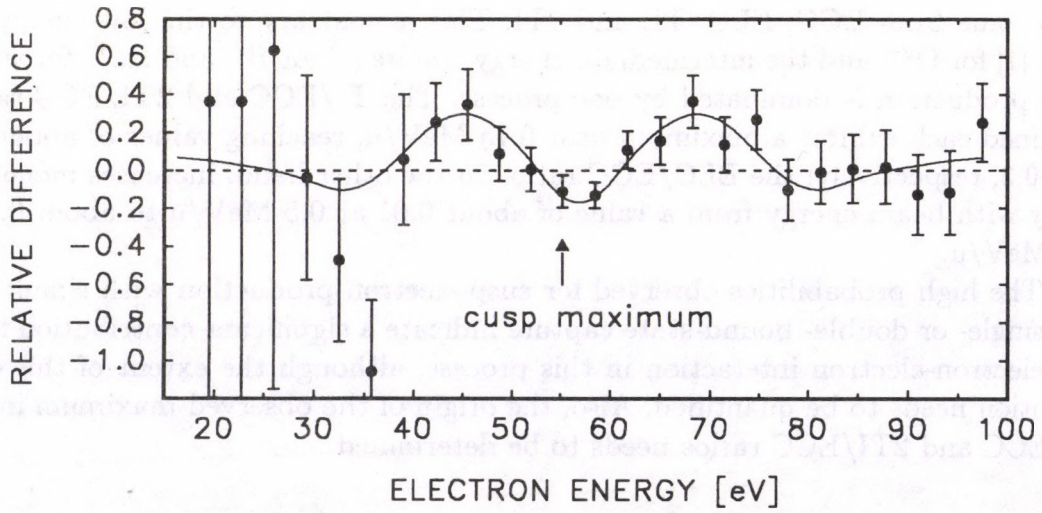
1. J. A. Tanis *et al.*: Phys. Rev. A **42** 5776 (1990); V. L. Plano *et al.*: Nucl. Instr. and Meth. B **86** 181 (1994)
2. L. Sarkadi *et al.*: ATOMKI Annual Report, 1993, p. 62.; P. A. Závodszky *et al.*: Nucl. Instr. and Meth. B **79** 67 (1993)

Shape of the ECC Cusp at Impact of Ground-State and Metastable Neutral He Projectiles

M. Kuzel †, L. Víkor $, P. A. Závodszky, L. Sarkadi,
R. Maier †, D. Berényi and K. O. Groeneveld †

To explain the observation [1] that the ECC cusp exists also for *neutral* projectiles, Barrachina [2] has shown that a modified electron–neutral atom interaction due to the presence of a low-lying virtual resonance state in the electron–projectile system can lead to a cusp in agreement with the experiment. For He^0 projectile a suitable virtual state can be found in the e–He system, when the He core is in a *metastable* 2^1S excited state. In a previous experiment [3] we indeed observed an enhanced emission of cusp electrons at impact of metastable He^0 particles with respect to ground-state projectiles.

To give further evidence for the formation of an intermediate virtual state, in the present work we made further experiments to decide whether the shapes of the ECC cusp for the two kinds of excitation are identical. (According to the picture given by Barrachina [1] one expects identical shapes.) In the figure below the relative difference between electron spectra taken by a 'mixed' (23% He^{0*} + 77% He^0) beam and a ground-state He^0 beam is shown for 400 keV impact energy. Small, but definite deviations occur symmetrically around the cusp maximum, indicating that other processes than that suggested by Barrachina may also contribute to the ECC cusp at neutral particle impact.



† Institut für Kernphysik der J. W. Goethe-Universität, D-60486 Frankfurt/M, Germany
$ Permanent address: Institute of Physics, Belgrade, Yugoslavia

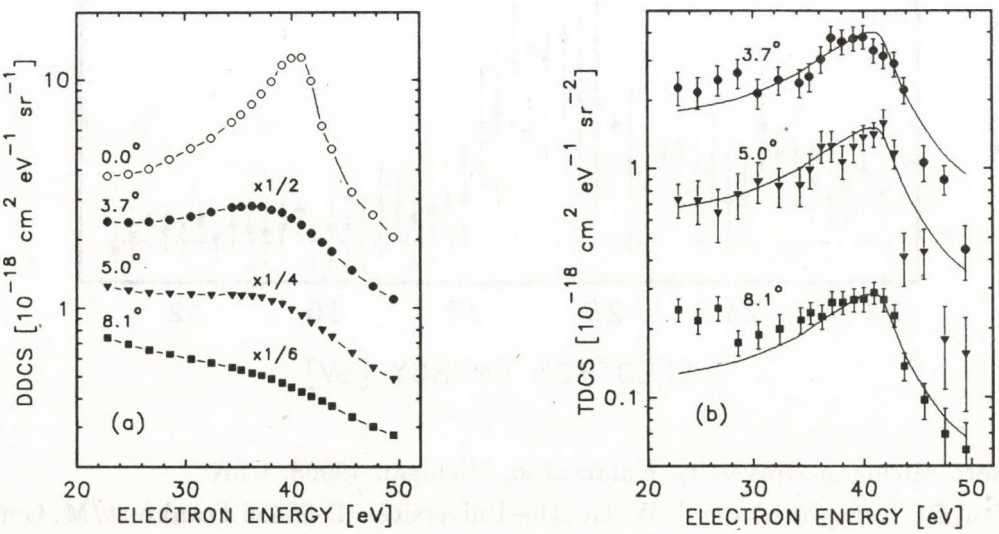
1. L. Sarkadi *et al.*: Phys. Rev. Lett. **62** 527 (1989)
2. R. O. Barrachina: J. Phys. B **23** 2321 (1990)
3. M. Kuzel *et al.*: Phys. Rev. A **48** R1745 (1993)

Angular Correlation of the Electron Cusp with Respect to the Scattered Projectiles in Proton on Argon Collisions

L. Sarkadi, U. Brinkmann †, A. Báder, R. Hippler †, and J. Pálinkás

The phenomenon of *electron capture to the continuum* (ECC [1]) still represents a challenge for the theory, mainly because of the difficulties arising for the three-body system in the case of the long-range Coulomb force. In this work we demonstrated the feasibility of a new kind of coincidence experiment, by which more differential information can be obtained about the dynamics of ECC. The basic idea is that the electron cusp is expected to appear also in 'non-zero-degree' emission angles, if the electron ejection is accompanied with a large-angle scattering of the projectile on the target nucleus in the same direction. For study of such a process one has to detect the electrons ejected in a given direction in coincidence with the projectiles emerging in the same direction.

The experiment was made using 75 keV proton beam and thin argon gas target. Doubly and triply differential cross sections (DDCS and TDCS) have been determined from yields of the 'singles' and coincidence events, respectively. As is seen from the figure below, while without coincident detection (part (a)) the cusp dominating the spectrum at 0° practically disappears at 8.1°, the electron spectra obtained in coincidence with the scattered protons (part (b)) have similar cusp shapes at each observation angles (3.7°, 5.0° and 8.1°), proving the existence of the ECC process at non-zero-degree emission angles.



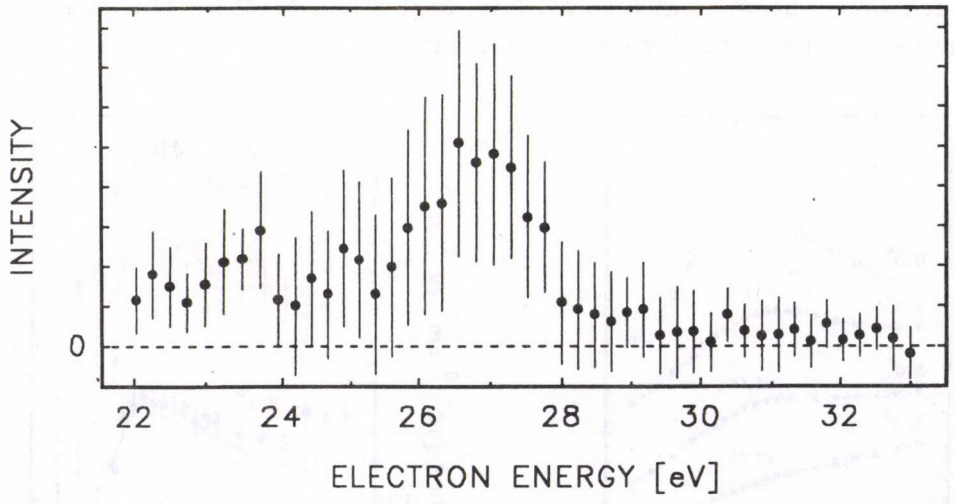
† Fakultät für Physik, Universität Bielefeld, 33501 Bielefeld, Germany

1. G. B. Crooks and M. E. Rudd: Phys. Rev. Lett. **25** 1599 (1970)

Further Study of Cusp-Electron Production by Transfer Ionization in Proton on Argon Collisions

L. Víkor [$], P. A. Závodszky [†], L. Sarkadi, J. A. Tanis [†], M. Kuzel [¶], A. Báder, J. Pálinkás, E. Y. Kamber [†], D. Berényi and K. O. Groeneveld [¶]

In the present work we continued our study of the role of *transfer ionization* (TI) in cusp-electron production in proton on argon collisions. TI is a process where the ejection of an electron (electrons) from the target is accompanied by capture of an additional target electron (electrons) by the projectile. In our earlier investigations [1] we measured relative cross sections for the cusp production by the two-electron process TI and by the dominant single-electron process ECC (*electron capture to the continuum*). In addition to determining TI/ECC ratios, our goal was to answer the question [2] of whether cusp-electron production leading to a *neutral* projectile in the final state [3] proceeds via a direct or an exchange mechanism. (For bare projectiles only the direct process is possible.) From the earlier TI spectra [1] we could not establish unambiguously the existence of a cusp. Therefore, we repeated the experiment at 50 keV impact energy with much better statistics. In the spectrum obtained in the latter measurements (shown in the figure) a peak clearly appears at $v_e = v_i$.



[†] Western Michigan University, Kalamazoo, Michigan 49008, USA
[¶] Institut für Kernphysik der J. W. Goethe-Universität, D-60486 Frankfurt/M, Germany
[$] Permanent address: Institute of Physics, Belgrade, Yugoslavia

1. L. Sarkadi *et al.*: ATOMKI Annual Report, 1993, p. 62.
2. A. Salin, private communication (1992)
3. L. Sarkadi *et al.*: Phys. Rev. Lett. **62** 527 (1989)

Observation of Convoy-electrons from Thick Au-foil Induced by Rutherford-scattered Protons

A. Báder, U. Brinkmann†, L. Sarkadi, R. Hippler† and J. Pálinkás

†Universität Bielefeld, Fakultät für Physik, Universitätsstrasse 25, 33615 Bielefeld, Germany

Convoy-electrons, which are ejected with the same velocity as the projectile ion penetrating a solid foil, were first observed in 1970 as a dominant cusp-like peak in the spectrum of the forward scattered electrons[1,2]. Up to now emission of convoy-electrons has been investigated only in the beam direction, i.e. when the projectile penetrates through the solid without any or very small deflection. Convoy-electron production by Rutherford-scattered projectiles on heavy target atoms, where the scattering significantly affects the electron emission, has not been measured. Furthermore, the existing models for convoy-electron production are rather controversial and this necessitates more investigation in this field.

To demonstrate the convoy-electron production by Rutherford-scattered ions, we bombarded a 150 $\mu g/cm^2$ vacuum-evaporated Au-foil with 200 keV protons and measured the electron energy spectrum at 54° relative to the beam direction in coincidence with the projectiles scattered in the same direction. The measurements have been performed at the 350 kV accelerator of the University of Bielefeld (Germany). In single measurements, the energy spectrum of electrons showed no evidence of any peak at 54°. In the spectrum measured in coincidence with protons emerging in the same direction, however, a peak can be observed at electron energy which corresponds to the velocity of the scattared protons (see Fig. 1).

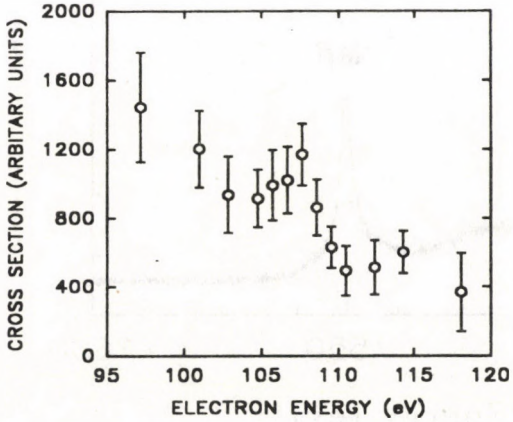


Figure 1 - Energy spectrum of electrons emitted in 54° from 200 keV $p^+ \rightarrow 150$ $\mu g/cm^2$ Au-foil reaction, detected in coincidence with protons scattered in the same direction.

Further study of the convoy-electron production by Rutherford-scattered ions will be discussed.

Work is supported by Hungarian Scientific Research Foundation (OTKA), Grant No 3018 and by the Deutsche Forschungsgemeinschaft.

References

[1]K. G. Harrison and M. W. Lucas Phys. Lett. 25, 1599 (1970)

[2]M. Breinig, S. B. Elston, S. Huldt, L. Liljeby, C. R. Vane, S. D. Berry, G. A. Glass, M. Schauer, I. A. Sellin, G. D. Alton, S. Datz, S. Overbury, R. Laubert and M. Suter Phys. Rev. A **25**, 3015 (1982)

Spectral Properties of the tungsten Mα,β lines determined by the PAX method

T. Papp and D. Varga

The method of PAX, photoelectron spectrometry for the analysis of x-rays [1], is based on the photoelectric effect in which the entire energy of the photon is transferred to an orbital electron. The x-ray spectrum can be reconstructedFrom the measurement of the energy and intensity distribution of the photoelectrons.

Our plan is to apply the PAX method for the determination of the line shape of x-ray transitions. As a first step we have studied the x-rays of a commonly used tungsten x-ray tube. The x-rays were converted to photoelectrons by a carbon foil. The photoelectrons were analyzed by a hemispherical analyzer, (named ESA31) [2]. A typical spectrum is presented in fig. 1. Aluminum Kα excited photoelectron spectrum of the same carbon foil was used to determine the properties of the converter level (carbon 1s) and the spectrometer transmission function. The present spectrometer gives a possibility to apply this method up to 10 keV and the quality of the spectra merits credit for further study.

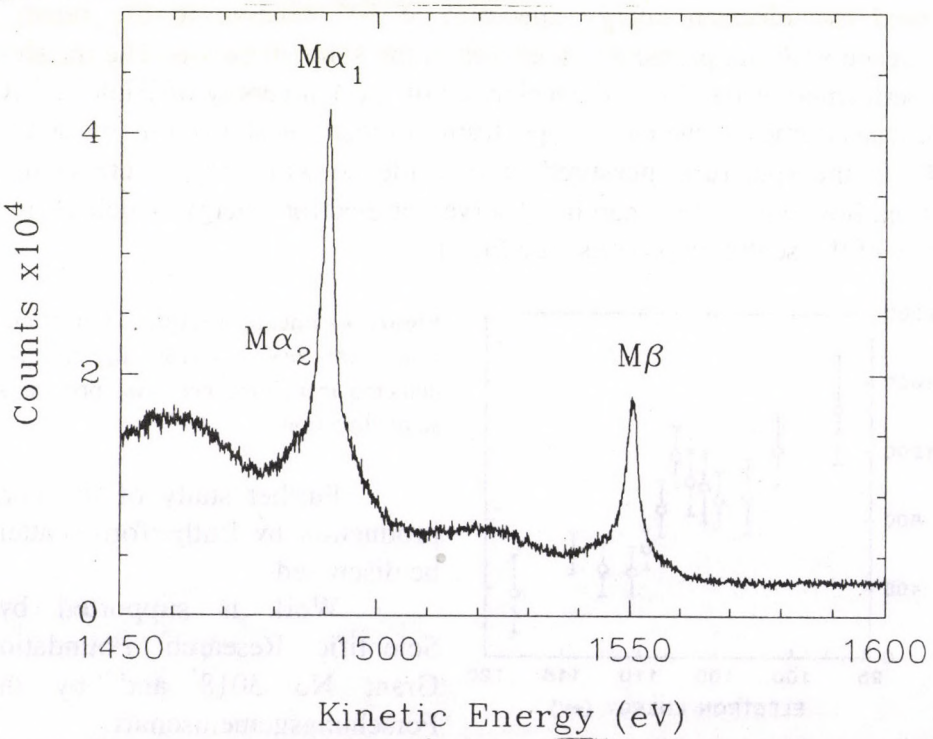


Figure 1. Mα,β x-rays of tungsten excited by 25 keV electrons. The x-rays were measured by the PAX method. Carbon 1s level was used to convert the x-rays to photoelectrons.

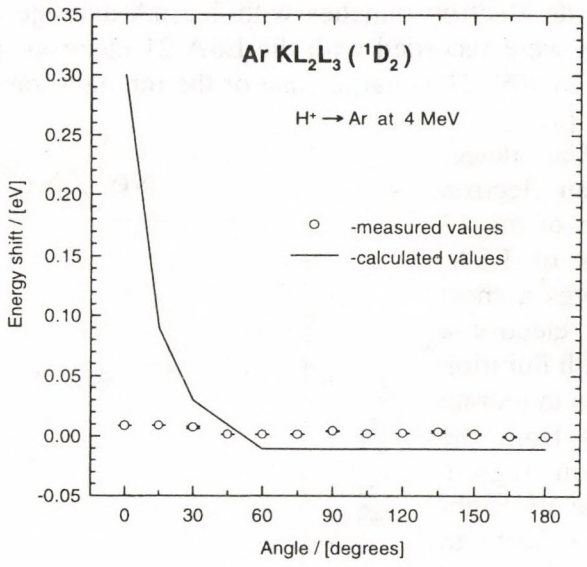
[1] M. O. Krause Physics Letters 74A (1979) 303
[2] L. Kövér, D. Varga, I. Cserny J. Tóth and K. Tőkési, Surface and Interface Analysis 19 (1992) 9

Angular Distribution of Post Collision Interaction at Ar KLL Auger Transition

Gy. Víkor, L. Tóth, S. Ricz, P.Pelicon#, Á. Kövér, B. Sulik and J. Végh*

We continued our systematic study on the angular distribution of the energy shift of Auger lines caused by post collision interaction (PCI) in ion-atom collisions. Recently the Ar KL_2L_3 Auger line ($^1D_2$) was measured at 4 MeV H^+ impact.

The electron spectra were recorded by the ESA-21 electron spectrometer [1]. Due to the relatively small cross section of the KLL Auger transitions, wider entrance slit were used which enable no better than 0.14 % (FWHM) analyzer resolution. This is 3 times larger than the natural line width.



The measured Auger lines were fitted by an asymmetric line shape proposed by Kuchiev [2] with the EWA evaluation program [3]. The angular distribution of the energy shift was determined. Figure shows the results, compared with the calculated values from the theory of Barrachina and Macek [4] .

The measured shifts are almost the same for all angles, but they are in contradiction with our previous measurements (Ne KLL and Ar LMM Auger spectra [5], [6]). Furthermore the calculated values are much larger at small forward angles than the measured ones. The possible reason of this surprising result is that the Auger transition is deeply inside the atomic core and the spectator electrons screen out the effect of the projectile. This measurement indicates the necessity to extend the existing PCI theories with screening .

References:

*Permanent address: Institute of Physics, P.O.Box 57, 11001 Belgrade, Yugoslavia
#Institute Jozef Stefan, P.O.Box 100, 61111 Ljubljana, Slovenia

[1] D.Varga, I.Kádár, S.Ricz, J.Végh, A.Kövér, B.Sulik and D.Berényi, NIM **A313**, (1992) 163
[2] M. Yu. Kuchiev and S.A. Sheinermann, Sov.Phys.-JETP 63 (1986) 986
[3] J. Végh, Thesis, ATOMKI (1990), unpublished.
[4] R.O.Barrachina and I.H. Macek, J.Phys. **B22** (1989) 2151
[5] E.Takács L.Sarkadi, S.Ricz, B.Sulik and L.Tóth, J. Phys. **B24** (1991) L381
[6] L.Tóth, Gy.Víkor, S.Ricz, P.Pelicon and R.Miller, NIM **B86**, (1994), 151

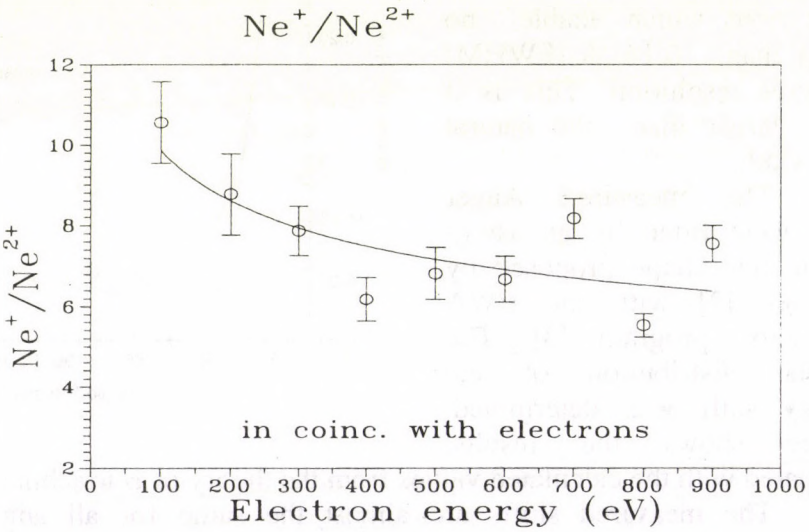
The ratio of the Ne^+ and Ne^{2+} remnant ions in coincidence with the inelastically scattered electrons

Gy. Víkor, L. Tóth, S. Ricz, Á. Kövér, and J. Végh*

Very few data can be found in the literature where the multiple ionization of gases was studied in function of the energy of the inelastically scattered electrons. We measured the inelastically scattered electrons from 3 keV $e^- \rightarrow$ Ne collisions in coincidence with the remnant ions in different charge states.

A special electron gun was used to ionize the Ne target. The gun produced 3 keV 20 ns wide electron bunches with 1-2 nA average current.(See in details in [2].) The electrons were recorded with the ESA-21 electron spectrometer [1] at every 15^o angle from 0^o to 90^o. The charge state of the remnant ions were determined with a recoil ion analyser [3].

The detection of an electron with one of the 13 detectors of ESA-21 initiates a short -200 V electronic pulse with duration of 300 ns to extract the ions from the interaction region. The time of flight of ions reflects to their mass and charge ratio.



The figure shows the measured ratio of the Ne^+ and Ne^{2+} remnant ions in coincidence with the inelastically scattered electrons in the 100 - 900 eV energy region. It is clearly seen that the ratio slowly decreases with increasing electron energy indicating that at larger momentum transfer the probability of multiple ionization is higher.

References:

*Permanent address: Institute of Physics, P.O.Box 57, 11001 Belgrade, Yugoslavia

[1] D.Varga, I.Kádár, S.Ricz, J.Végh, A.Kövér, B.Sulik and D.Berényi, Nuclear Instruments and Methods **A313**, (1992) 163

[2] Gy. Víkor, L. Tóth, S. Ricz, Á. Kövér, and J. Végh, recent Annual Report

[3] Gy. Víkor, L. Tóth, S. Ricz, Á. Kövér, and J. Végh, recent Annual Report

KLL and KLM Auger Spectra of Transition Metals in the Atomic Number Region of 23-26

A. Némethy, L. Kövér, I. Cserny, D. Varga and P.B. Barna*

*Research Institut for Technical Physics of the Hungarian Academy of Sciences
H-1518 Budapest, P.O.Box 132, Hungary

KLL and KLM Auger spectra of V, Cr, Mn and Fe layers of 30 nm thickness evaporated onto Si substrates were excited by W bremsstrahlung and measured by a high luminosity electron spectrometer [1] with an overall energy resolution of 1.0-1.6 eV. The experimental KLL spectra are shown on Fig. 1. Table 1 contains the measured transition energies (first experimental data, except for Mn) for the highest intensity lines of the KLL and KLM Auger spectra, compared with two sets of values derived from different calculations. The large deviations between the experiment and theory can probably be attributed to the neglection of the relativistic effects and of the presence of the core hole in the initial state of the Auger process. Regarding the relative Auger transition energies and peak intensities a general agreement can be observed between our results and those obtained earlier by Kovalik et al. [4], while in a number of cases the deviations can be explained by the higher energy resolution, the better defined chemical state of the specimen and the physically more plausible spectrum evaluation method applied in our work.

Table 1. KLL and KLM Auger transition energies for V, Cr, Mn and Fe

Transition		Present meas.	Theory [2]	Theory [3]
	V	4394.3(0.8)	4379.9	4383.2
KL_2L_3	Cr	4790.7(0.9)	4777.8	4787.1
($^1D_2$)	Mn	5208.2(0.8)	5191.7	5195.7
	Fe	5640.6(0.8)	5624.8	5629.2
	V	4904.6(1.2)	4894.6	4857.9
KL_2M_3	Cr	5360.8(0.9)	5391.3	5317.7
($^1D_2$)	Mn	5837.6(0.9)	5826.9	5787.2
	Fe	6334.5(0.9)	6324.4	6283.4

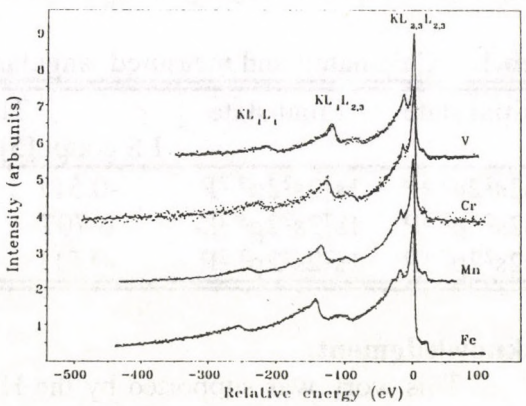


Fig.1. The measured photoinduced KLL Spectra of V, Cr, Mn and Fe.

References

[1] L. Kövér, D. Varga, I. Cserny, J. Tóth and K. Tőkési, Surface and Interface Anal. **19** (1992) 9

[2] F.P. Larkins, At. Data and Nucl. Data Tables **20** (1977) 311

[3] S.T. Perkins, D.E. Cullen, M.H. Chen, J.H. Hubbel, J. Rathkopf, J. Scofield, UCRL-50400, **30** (1991), Lawrence Livermore National Laboratory, Livermore, CA

[4] A. Kovalik, V. Brabec, J. Novák, O. Dragoun, V.M. Gorozhankin, A.F. Novgorodov and Ts. Vylov, J. Electron Spectrosc. and Rel. Phenom. **50** (1990) 442

Experimental study of the coherence and correlation effects in the anisotropy of Ne KLL satellite Auger spectra ionized by 700-2000 keV proton impact

L. Tóth, S. Ricz, E.Takács, B.Sulik, J. Végh, I. Kádár

The measurement were performed on the ESA-21 triple stage electrostatic spectrometer [1]. This device allows one to measure high resolution electron spectra simultaneously at 13 observation angles in the scattering plane from 0° to 180° relative to the beam direction in steps of 15°. The width of the slits in the second stage of the spectrometer was set to 0.4 mm. The p beam was produced by the 5 MeV Van de Graaff accelerator at ATOMKI.

The spectra were analyzed using the EWA computer code [2] with the peaks fitted to an asymmetrical line shape given by Kuchiew and Sheinerman [3]. The peak shape was convoluted with the spectrometer function, which was assumed to be Gaussian, and the Lorentzian width of the lines was fixed at 0.27 eV.

The angular anisotropy of electron emission is especially sensitive to the coupling of spin and orbital angular momenta in the initial and final bound states of Auger emission. N.M. Kabachnik [4] suggested a modification of the general expression for the angular distribution, which is more convenient for relativistic calculations. Our measurement (Tab. 1.) agree with Kabachniks' calculation. It has been shown that the relativistic effects are important in this intermediate atomic number region, and the initial double-hole states belonging to the same multiplet partially overlap.

Tab.1. Calculated and measured angular anisotropy parameters

Initial state	Final state	Theory		Experiment	
		LS coupl.[5]	[4]	[5]	This work
$1s2s^22p^5\ ^3P$	$1s^22s^22p^3\ ^2P$	-0.511	-0.405	-0.75(20)	-0.27(14)
$1s2s^22p^5\ ^3P$	$1s^22s^22p^3\ ^2D$	0.707	0.573	0.62(15)	0.47(9)
$1s2s^22p^5\ ^1P$	$1s^22s^22p^3\ ^2P$	-0.511	-0.498	-0.44(23)	-0.40(8)

Acknowledgment

This work was supported by the Hungarian National Science Found (OTKA No. 3011) and Research Found of the Sciences (AKA No. 1-300-2-91-0-790).

References

[1] A. Kövér *et al.*, J.Phys. B **16** (1983) 1017.
[2] J. Végh, Thesis, ATOMKI (1990), *unpublished*,.
[3] M.Yu.Kuchiev and S.A.Sheinermann, Sov.Phys.-JETP **63** (1986) 986.
[4] N.M. Kabachnik, Phys. Rev. A **49** (1994) p4653.
[5] S. Ricz, Nucl. Instr. and Meth. B **61**, 411 (1991)

Effects of Oxygen Chemisorption on K-Valence Auger- and Valence Band Photoemission Spectra of Al

Zs. Kovács, L. Kövér, D. Varga, P. Weightman[1], R. Sanjinés[2], G. Margaritondo[2], J. Pálinkás and H. Adachi[3]

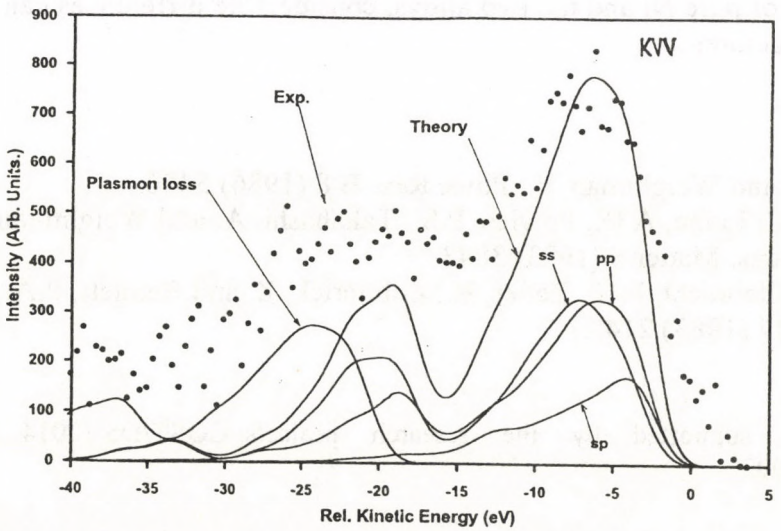
[1]Department of Physics and Interdisciplinary Research Center in Surface Science University of Liverpool, P.O. 147, L69 3BX, UK

[2]Institut de Physique Appl., Ecole Polytechnique Fédérale CH-1015 Lausanne, Switzerland

[3]Dept. of Metallurgy, Kyoto University, Yoshida-honmachi, Kyoto 606, Japan

Ground state density functions of electron states (DOS) have been calculated for aluminium-oxygen systems representing different distributions (i.e different local symmetries) of oxygen chemisorption sites ("top", "bridge" and "hollow"). The calculations have been performed using a cluster type molecular orbital (DVXα) method, making possible the separation of contributions from atoms in nonequivalent positions.

Using the atomic Auger matrix elements and applying the final state rule, the core valence-valence Auger lineshapes were determined from the ground state DOS. The theoretical Al KVV Auger- and valence band XPS spectra of various Al- adsorbed oxygen systems have been compared to our experimental spectra obtained for oxidized Al surfaces of polycrystalline samples. The hybridization between the aluminium and oxygen orbitals was determined for σ (Al 3p and O 2p) and π (Al 3p, 3s and O 2p) orbitals in the case of different chemisorption sites by analysing the results of the calculations. The effect of the presence of the oxygen can be observed on the spectral distributions (Fig. 1). Mainly due to the contribution (different for each type of chemisorption) from the oxygen 2p level.



1. T. Tanabe, H. Adachi, S. Imoto, Jap. Journal of Applied Physics, **17** (1978) 49-58
2. E.R. Wouters *et al.*, The initial stages of the oxidation of Al(111), Surface Science **296** (1993) 141-148

This work was supported by the research projects: COST/D5/12014 (CEC) and OTKA/T007274/1993

The Influence of the Ni *d* Band on the Local Density of States Al in Al_3Ni and $AlNi_3$ Alloys.

L. Kövér, Zs. Kovács, P. Weightman[1], D. Varga, J. Pálinkás and H. Adachi[2]

[1]Department of Physics and Interdisciplinary Research Center in Surface Science, University of Liverpool, P.O. 147, L69 3BX, UK
[2]Dept. of Metallurgy, Kyoto University,Yoshida-honmachi, Kyoto 606, Japan

The study of the effect of the local electronic environment on atomic processes taking place in components of alloys of technological importance, can provide valuable information for the understanding of the phase diagram and the properties of these materials. In this work we present our experimental Al KL_{23} Auger, Al 1s and 2p photoemission, Ni L_3VV-Auger and Ni 2p and 3p photoemission spectra of Al_3Ni and $AlNi_3$ singlecrystal alloy samples. The measurements were carried out using a high luminosity electron spectrometer and Mo-X rays and Al Kα radiation were used for excitation.

From the core-valence (Al $KL_{23}V$ and Ni L_3VV) Auger spectra information can be obtained on the site projected local density of electron states and on the role of the different excitation processes.

The experimental Al $KL_{23}V$ Auger lineshapes were compared to the high resolution XPS valence band spectra obtained in previous measurement, and to the results of our calculations using a semiempirical model (atomic Auger matrix elements correction) based on cluster MO calculations with a final state core hole. Comparing the Ni L_3VV spectra of pure Ni and the two alloys, considerable differences can be observed in the satellite structures.

References

1. Thomas , T.D. and Weightman, P., Phys. Rev. B **8** (1986) 5406
2. Gregory, D.A.C, Laine, A.D., Fowles, P.S., Takahashi, A. and Weightman, P., J. Phys.: Condens. Matter **5** (1993) 3843
3. Fuggle, J.C, Hillebrecht, F.U., Zeller, R., Zolnierick, Z. and Bennett, P.A., Phys. Rev. B **27** (1983) 2145.

This work was supported by the research projects: COST/D5/12014 (CEC) and OTKA/T007274/1993

Dominant two-center electron-electron interaction in collisions of 120 MeV Ne^{6+} ions with gas targets

B. Sulik, S. Ricz, I. Kádár, G. Xiao, G. Schiwietz*, K. Sommer*, P. Grande*, R. Köhrbrück*, M. Grether* and N. Stolterfoht**

The relative contribution of the screened target nucleus - projectile electron interaction (screening effect) and the target electron - projectile electron interaction (dielectronic two-center process) in the excitation of the projectile has been studied both experimentally and theoretically. [1,2] Several gas targets (H_2, He, CH_4, N_2, Ne, Ar) were bombarded by 120 MeV Ne^{6+} ions to study the $2s$-$n\ell$ excitation of the metastable Ne^{6+} $1s^2 2s2p\ ^3P_0$ projectile. The experiments were performed at a beam line of the VICKSI accelerator facility in Hahn-Meitner-Institute, Berlin. The ejected electron spectra were acquired by a tandem electron spectrometer at zero degree relative to the beam direction. The Coster-Kronig electrons from the transition $1s^2 2p\ n\ell$ ($n \geq 7$) -> $1s^2 2s + e^-$ were measured using the method of zero-degree electron spectroscopy. It was found that the production cross section for the Coster-Kronig electrons is roughly proportional to the target atomic number. The experimental data are in agreement with the first order plane-wave Born approximation (PWBA) calculations [3] for hydrogen and helium targets where theory predicts the dominance of dielectronic two-center processes. For heavier targets, PWBA predicts that the screened nuclear contribution to the cross section is dominant. PWBA cross sections significantly overestimate the experimental data for targets heavier than helium. Performing impact-parameter dependent calculations within the framework of the semiclassical approximation (SCA) [4,5], we have found that the the quenching of the metastable state by exciting or ionizing the $2p$ electron is a non-negligable process at heavier targets. When taking this process into account, the agreement between experiment and theory is generally good. We found that in the production of the Coster-Kronig electrons, the dielectronic contribution is dominant for light targets (67% for hydrogen and 57% for helium), and significant for all the investigated targets (20% for argon). A systematic extension to heavier targets is under work.

References:

* Hahn-Meitner Institute, Glienicker Str. 100, D-14109 Berlin, Germany

[1] N. Stolterfoht, Nucl. Instr. Meth. **B53**, 477 (1991).

[2] J. H. McGuire, N. Stolterfoht and P. R. Simony, Phys. Rev. **A24**, 97 (1981).

[3] E. C. Montenegro and W. E. Meyerhof, Phys Rev. **A43,** 2289 (1991).

[4] S. Ricz, B. Sulik, N. Stolterfoht and I. Kádár, Phys. Rev. **A47**, 1930 (1993).

[5] G. Schiwietz and P. L. Grande, Radiation Effects and Defects in Solids **130,** 137 (1994).

P LVV Auger Spectra of Phosphorus Oxyanions

L. Kövér, I. Cserny, A. Némethy and H. Adachi*

*Dept. of Material Science and Engineering, Kyoto University, Yoshida-honmachi, Kyoto 606, Japan

The effect of the local (group localization, common tetrahedral) symmetry was found earlier to dominate in the XPS, X-ray and X-ray excited Auger spectra of phosphorus oxyanions [1]. These spectra were successfully interpreted by using cluster MO calculations in combination with a semiempirical approach based on atomic transition probabilities. In the present work, P LVV Auger spectra of Li_3PO_4, Na_3PO_4, $(NaPO_3)_n$ and $Na_4P_2O_7$ polycrystalline powder samples were measured. W bremsstrahlung excited P LVV spectra were obtained by using a home built electron spectrometer [2]. In the case of the $Na_4P_2O_7$ the oxygen K-Auger parameter shifts were determined as well. Theoretical spectra were obtained by the DV-Xα cluster MO model [3] from the ground state local density of states (DOS). The P LVV Auger line shapes were calculated from the self-folded DOS $N(E)*N(E)$, where $N(E)=Np(E)+\alpha N_s(E)$ and $\alpha\approx0.3$ [4].

The experimental valence band and P $L_{2,3}$VV Auger spectra of the phosphorus oxyanions investigated are strongly dependent on the local geometry around the ionized P atom, however, the main structure of the spectra can be well approximated with the simplest PO_4^{3-} cluster model. Both the energy separations between the two most intensive (*ss* and *pp*) peaks and lineshapes of the highest intensity lines (*pp*) are well reproduced by the semiempirical model based on cluster MO calculations (Fig. 1). The small values of the relative K-Auger parameters of the oxygen in the case of NaPO indicate its small polarizability, similarly to other phosphorus oxyanions [5].

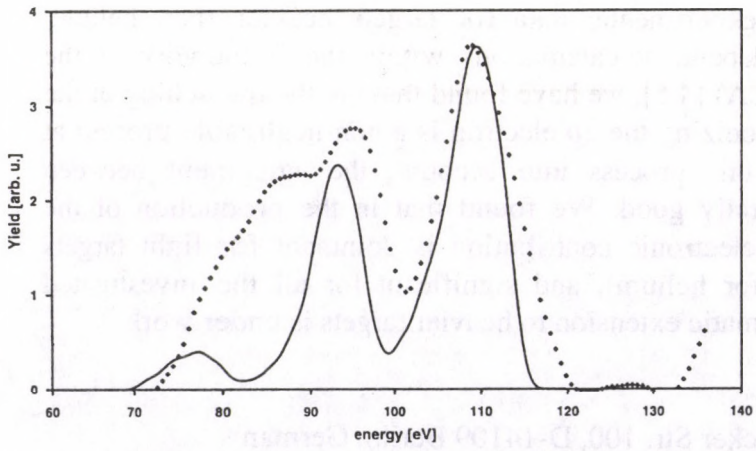


Figure 1. Theoretical P $L_{2,3}$VV Auger spectrum (line) of a PO_3^- embedded into a $P_4O_{13}^{4-}$ cluster, calculated by using DV-Xα cluster MO method, in comparison with the experimental P $L_{2,3}$VV Auger spectrum (dots) of the $(NaPO_3)_n$ sample.

References

[1] L. Kövér, A. Némethy, I. Cserny, A. Nisawa, Y. Ito and H. Adachi, Surf. Interface Anal. 22(1994) 45
[2] L. Kövér, D. Varga, I. Cserny, J. Tóth and K. Tőkési, ibid, 19 (1992) 9
[3] H. Adachi, M. Tsukuda and Ch. Satako, J. Phys. Soc. JPN, 45, No. 3 (1978) 875
[4] M. Sancrotti, L. Duo, L. Calliari, F. Manghi, R. Cosso and P. Weightman, Phys. Rev. B 46, No 20 (1992-II) 13607
[5] G. Moretti, Surf. Interface Anal., 58 (1992) 105

Effects of Electron-Electron Interaction in Ionization by Structured Particle Impact

K. Tőkési, J. Wang[1], R.E. Olson[2]

[1] Department of Physics, Tulane University New Orleans, LA 70118 USA
[2] Department of Physics, University of Missouri-Rolla Rolla, MO 65401 USA

Full and reduced four-body classical trajectory Monte Carlo methods are used to calculate the cross section of projectile ionization when the target electron is remaining bound (ground or excited states) in the H + H collision system. In the reduced CTMC pictures, the projectile electron-target electron interaction was switched off, ie V(n-e) only, or the projectile electron-target nucleus interaction was switched off, V(e-e) only. We find large differences in the shape and the asymmetry of the electron loss peak (see Fig. 1.) using the full and reduced four-body systems.

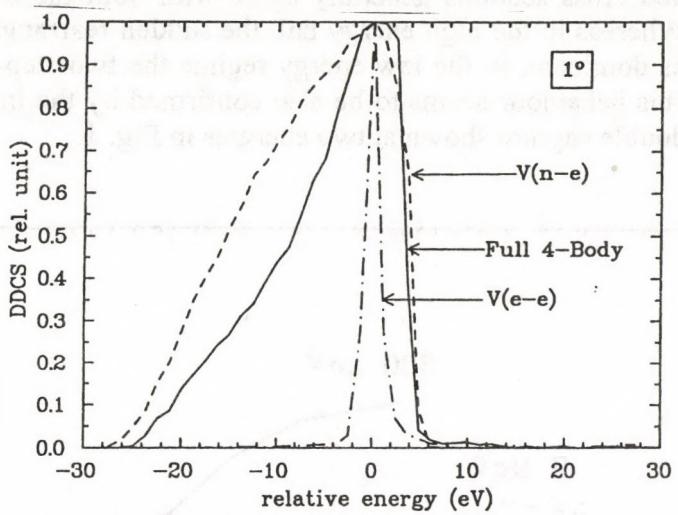


Figure 1. Double differential cross section (in relative unit) for ejection of electrons from the projectile in collision of $H+H$ as a function of the relative energy (E). $E=E_{electron}-E_0$, where $E_0=m_e v_p^2/2$; v_p is the velocity of the projectile and m_e is the mass of the electron, respectively. The amplitudes are normalised to the maximum peak intensities.

These differences are interpreted in terms of the contributions from the V(n-e) and V(e-e). Screening effects are clearly visible. Of course, in an actual experiment, the ELC peak cannot simply be decomposed into V(n-e) and V(e-e) contributions by the emitted electron spectra alone. However, there are indications that the V(e-e) and V(n-e) probe different parts of the impact parameter region. By measuring the ELC peak in coincidence with the projectile scattering angle, one may infer the impact parameter dependence, therefore determining the relative contributions.

References

K. Tőkési, J. Wang, R.E. Olson, HCI '94, Vienna, 1994. Sept 19-23, Book of Abstracts, Tu22.

Electron Capture in $He^{2+} + He$ Collisions up to 1500 keV/amu Projectile Impact

K. Tőkési and G. Hock

The double electron capture at the higher impact energy region has received a growing interest from both theoretical and experimental points of view. The theoretical studies concentrated mainly on the impact energy range of 100–375 keV/amu where most of the experimental data are available.

In the present work we have calculated the cross sections of the double electron capture processes as a function of the impact energy for the $He^{2+} \rightarrow He$ collision system. The cross sections were obtained by the help of the four-body classical trajectory Monte Carlo method using the independent electron model, i.e. with the complete neglect of the electron–electron interaction during the collision.

The calculated cross sections generally agree with both the experimental and theoretical values. Whereas in the high energy tail, the sudden rearrangement involving resonance features is dominant, in the low energy regime the two-step-like mechanism can be perceived. This behaviour seems to be also confirmed by the impact parameter dependence of the double capture shown at two energies in Fig. 1.

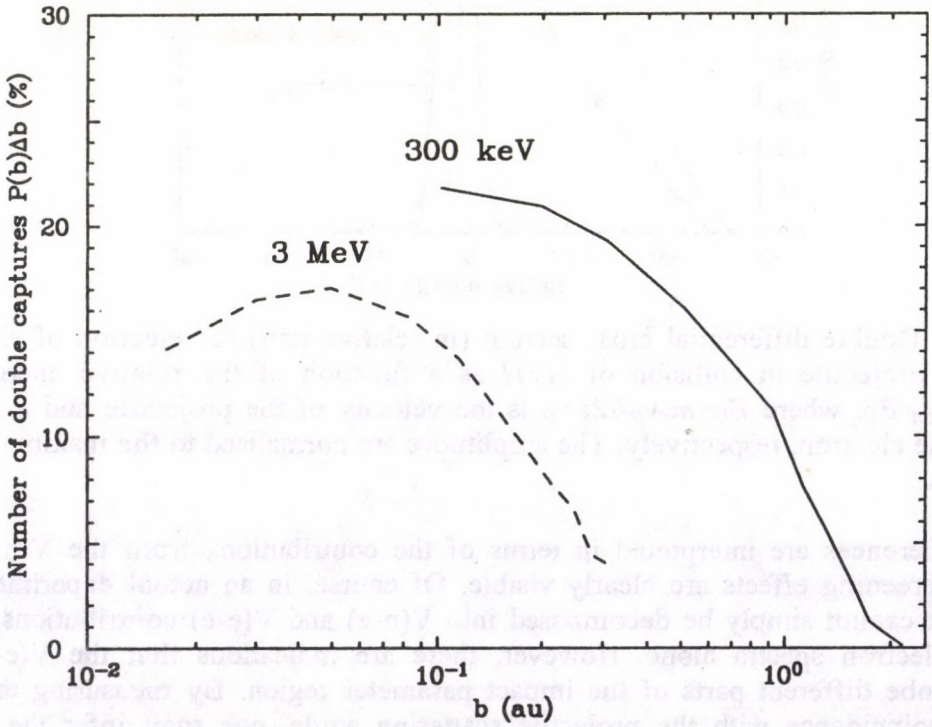


Figure 1. The impact parameter dependence of the total double electron capture at 300 keV and 3 MeV impact energies.

References

K. Tőkési and G. Hock, HCI '94, Vienna, 1994. Sept 19-23, Book of Abstracts, Tu23.

Target multiple ionization in collision with fast, bare ions: The extension of the energy deposition model

*B. Sulik and T. Mukoyama**

The multiple ionization of the target by fast ion projectiles is usually treated within the framework of the independent particle model (IPM). [1] This is true for either classical [2,3] or semiclassical [4] theories. Of course, dynamic electron-electron correlation effects can not be taken into account within the IPM framework. The basic problem connected to the independent particle model is the dependence of the ionization treshold on the degree of ionization. Even the first ionization potential is strongly determined by the presence of the other electrons. This can be considered as a mean-field component of the electron-electron correlation. It can be taken into account on sophisticated ways for single ionization [5]. However, for multiple ionization, there is no consistent general solution of the problem. Approximate solutions work rather well for the multiple ionization of the innel shells where the dependence of the ionization potential on the degree of (inner shell) ionization is weak [4]. For outer shells, the above dependence is always strong.

There exist a fully statistical model for the description of the multiple ionization of the outer shells at slow (adiabatic) ion-atom collisions. Within the freamwork of this energy deposition model (EDM) [6] one may calculate the distribution of the final charge states of an atom from the density of states in the n-electron continuum and from the known amount of energy deposited to the (outer shell of the) atom. We have made an attempt to extend the applicability of EDM to high velocity collisions. We determine semiclassically a density distribution of the energy deposited to an atom, or to a given shell of an atom in the collision. Then we average the energy-dependent EDM probabilities over the density distribution determined in the first step.

Preliminary results show good agreement with a bulk of experimental data, for measured multiple ionization cross sections and probabilities.

References:

* Department of States and Structures, Kyoto University, Uji, Japan

[1] J. H. McGuire, Adv. At. Mol. Opt. Phys., **29**, 217-323 (1992).

[2] B. Sulik, I. Kádár, S. Ricz, D. Varga, J. Végh, G. Hock and D. Berényi, Nucl. Instr. Meth. **B28**, 509 (1987).

[3] R. Olson, J. Ullrich and H. Schmidt-Böcking, Phys. Rev. **A39,** 5572 (1989)

[4] J. M. Hansteen and O. P. Mosebekk, Phys. Rev. Lett. **29**, 1361 (1972)

[5] E. Merzbacher and H. W. Lewis, Handb. Phys. **34** (Springer Verlag, Berlin, 1958) p. 166.

[6] A. Russek and J. Meli, Physica **46**, 222 (1970).

Coster-Kronig yields of the xenon L-subshells measured with the synchrotron photoionization method

W. Jitschin[1], R. Stötzel[1], T. Papp, M. Sarkar[2] and C. D. Doolen[3]
[1] Fachbereich MNI Fachhochschule Giessen-Friedberg, Germany, [2] Saha Institute of Nuclear Physics, Calcutta, India, [3] Los Alamos National Laboratory, Los Alamos, USA

The method of selective photoionization of individual subshells by monochromatized synchrotron radiation has been employed to measure all Coster-Kronig yields of the Xe L-subshells. The induced fluorescence was recorded by a Si(Li)-detector at numerous energies of the primary radiation and normalized to the simultaneously measured Ar K-fluorescence. Both Ar and Xe were in the gaseous state. The recorded fluorescence spectra were carefully analyzed with proper modeling of the line tailing caused by the detector. The x-ray lineshape was the convolution of the Lorentzian profile with the detector response function. The analysis of the Lγ group is complicated by the strong coupling between the single hole level and the continuum. The single particle model breaks down and as a consequence the core hole energy exhibit large shifts and the decay rate is largely modified [1]. This modified lineshape was also incorporated in the analysis. In figure 1. two fits are presented where the many-body effect was either neglected and incorporated in the fit.

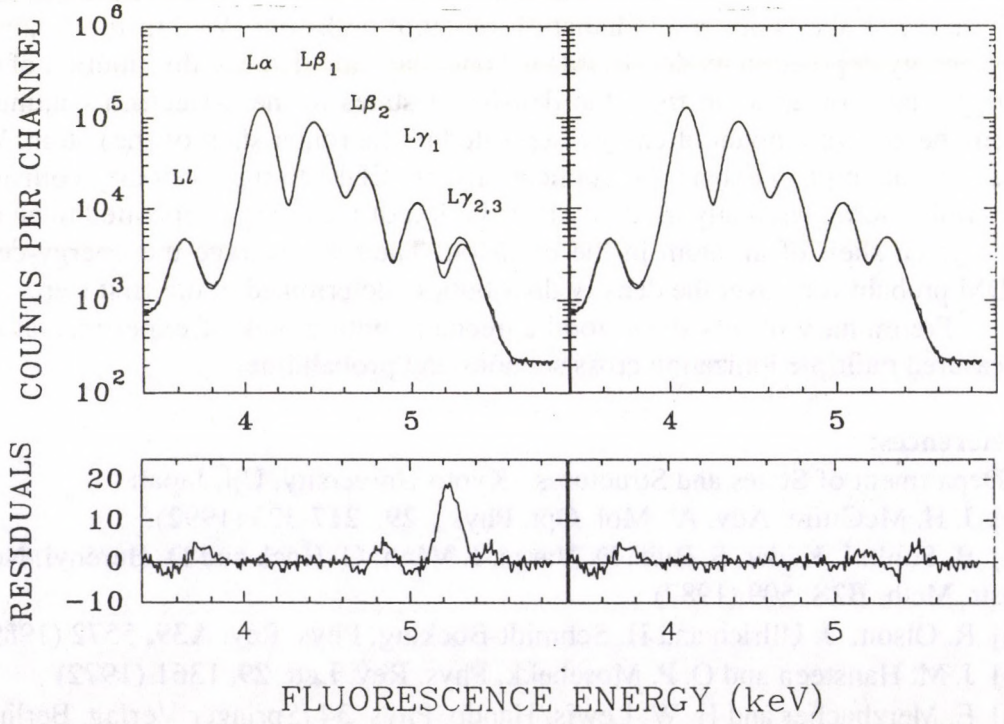


Figure 1. L spectrum of xenon recorded with a Si(Li) detector. In the left hand side figure the spectrum has been least-square fitted using proper detector response function. In the right hand case the modified line shape, caused by the break down of the single particle picture, was also incorporated.

[1] M. Ohno and R. E. LaVilla, Phys. Rev. A38, 3479 (1988)

Modeling of in-sample Compton scattering of fluorescent x-rays

T. Papp and G. Kalinka

The high energy part of x-rays observable by a Si(Li) detector usually contains Compton scattered x-rays as well. Several earlier studies e. g. [1] demonstrated the proper understanding of the detected line shapes. The Compton profile of a characteristic x-ray strongly depends on it's energy, the geometry applied and the atomic number of the scattering material. We have performed an analysis where a thin ^{125}I point source was placed between carbon layers at various thicknesses in front of and behind the source (see fig.1a). Spectra were taken with a Si(Li) detector at well defined 0°, 90° and 180° scattering angle. The shape of the Compton profile was obtained by subtracting the spectrum of the thin source from the spectrum of the source between the carbon layers (fig.1b) The difference spectrum was compared with the calculated shape in different models [2].

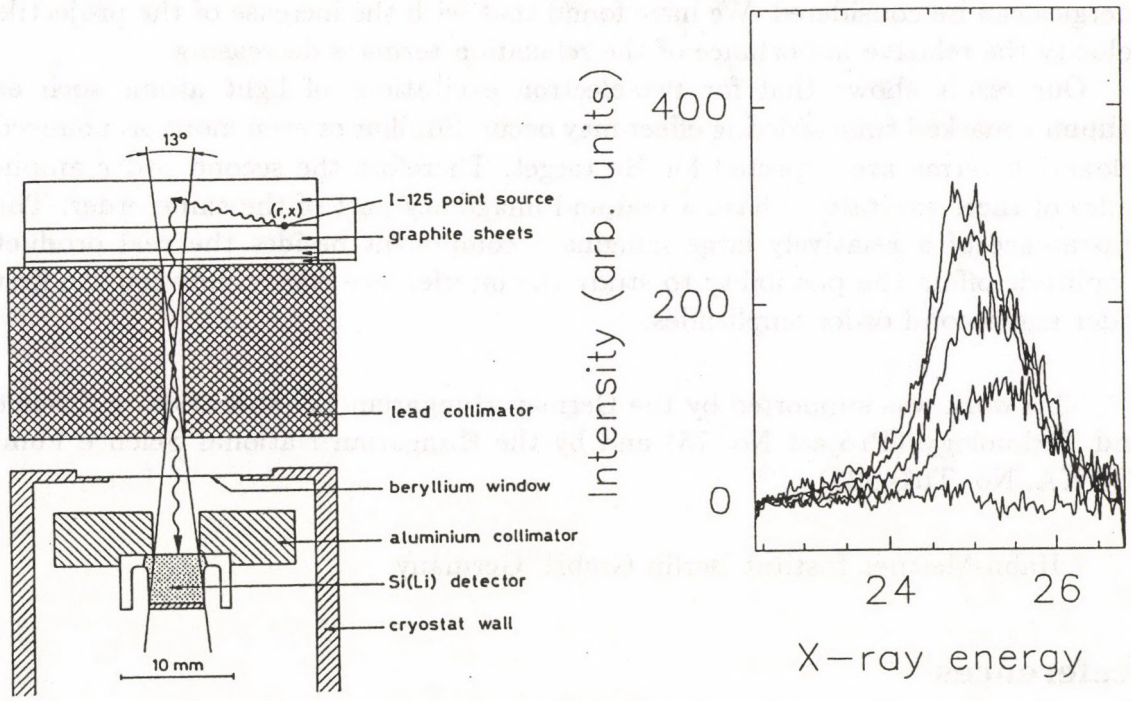


Figure 1a-b. The left hand part (1a) demonstrates the geometry applied, while in fig. 1b typical difference spectra are presented for backscattered x-rays at various (0.0, 0.5, 1.4, 4.4, and 16.5 mm) carbon thicknesses.

[1] T. He, R. P. Gardner and K. Verghese, Nucl. Inst. Meth. A299 (1990) 354
[2] G. Kalinka in this report

Time ordering contributions to the product amplitude of independent electron model

L. Végh, B. Sulik, N. Stolterfoht*

For a two-electron transition it was shown recently in paper[1] that the product amplitude of the independent-electron model can be derived as an approximation to the corresponding time-dependent second-order amplitudes. In the derivation the time-ordering effects were lost by the use of frozen energies and wave functions for the intermediate states of the second-order amplitude.

We have derived terms to the product of single-amplitudes for double excitation which are due to the relaxation of the target orbitals. These relaxation terms have real and imaginary components. Investigating the structure of these terms we find that for a real product amplitude the imaginary relaxation term is more relevant and the real part of the relaxation term is negligible.

Studying the structures of the terms, the applicability of the product amplitude for the calculation of the multielectron transition amplitudes at high projectile energies can be considered. We have found that with the increase of the projectile velocity the relative importance of the relaxation terms is decreasing.

Our result shows that for two-electron excitations of light atoms such as lithium a marked time ordering effect may occur. Similiar or even more pronounced relaxation terms are expected for He target. Therefore the second order amplitudes of these excitations have a real and imaginary part of the same order. The appearence of a relatively large imaginary component besides the real product amplitude offers the possibility to study the interference effects between the first order and second order amplitudes.

This work was supported by the German-Hungarian Collaboration in Science and Technology (Project No. 75) and by the Hungarian National Science Fund (OTKA, No. T014323)

* Hahn-Meitner Institut Berlin GmbH, Germany

References

1. N. Stolterfoht, Phys. Rev. **A48**, 2980 (1993).

Calculated ionization cross sections for proton–fullerene ion collisions

L. Nagy and L. Végh

The uniqe properties of the C_{60} (buckminsterfullerene) have induced several theoretical and experimental investigations. Recently Völpel et al. [1] have published experimental cross sections in the ionization and fragmentation of different fullerene ions by electron impact. They have presented absolute ionization cross sections at incident electron energies ranging from the threshold up to 1000 eV. The measured broad cross section maximum showing a flat plateau between about 50 and 250 eV incident electron energies is quite unusual.

We investigate the behavior of the calculated ionization cross sections of fullerene ions by proton impact within the framework of the semiclassical approximation. Our motivation is to enlighten the origin of the flat plateau found in the measured cross section for electron impact. If the plateau appears in the protonic cross sections, too, this would be a clear indication that the effect is characteristic for the C_{60} target and can be explained by the properties of the special electronic potential in the molecule.

A simple jellium model is developed in order to obtain one-electron wave functions for the valence electons of the fullerene. We have considered a spherically symmetric potential, created by a positive background charge plus a pseudopotential. The full potential has the form

$$V(r) = \int d\mathbf{r}' \frac{\rho(r')}{|\mathbf{r} - \mathbf{r}'|} - V_0 \exp\left[-\left(\frac{r - R_0}{a}\right)^2\right]$$

The charge density is presented as

$$\rho(r) = Z \frac{\exp\left[-\left(\frac{r-R_0}{a}\right)^2\right]}{\int d\mathbf{r} \exp\left[-\left(\frac{r-R_0}{a}\right)^2\right]},$$

where Z is the charge of the residual ion, for the C_{60}^+ is $Z = 2$. The parameters of the potential have been adjusted to regain the one-electron energy spectrum and to obtain the experimental ionization potential of the C_{60}^+.

With the jellium wave function we have calculated ionization cross sections for the C_{60}^+–proton collisions in the semiclassical approximation. For higher projectile velocities, for which the semiclassical approximation is valid also for electron impact, theoretical cross sections fit satisfactorily the experimental data [1]. No broad maximum was found in the cross section energy dependence, like for electron impact.

1. *R. Völpel et al, Phys. Rev. Lett.*, **71**, *3439 (1993).*

MATERIALS SCIENCE

AND

ANALYSIS

Anomalous Hall effect in $Bi_2Sr_2CaCu_2O_x$ single crystals

K. Vad, S. Mészáros, N. Hegman, G. Halász and B. Sas†

The mixed state of a type-II superconductor provides rare opportunity to explore the vortex dynamics, not only in the free flux flow state (near T_c) but at low temperatures, where the vortex system is pinned (vortex glass state). The Hall effect in the mixed state of high- and low-T_c type-II superconductors is a topic of great current interest and one surrounded by considerable contreversy and confusion. Central to the contreversy is the observed sign reversal of the Hall angle $\alpha = \rho_{xy}/\rho_{xx}$ as the system enters the superconducting state [1-3]. We have investigated the longitudinal and transversal voltages as a function of the current density for $Bi_2Sr_2CaCu_2O_x$ single crystals between $0 \div 5\ T$ magnetic field and in the $10 \div 200\ K$ temperature range. In the free-flux-flow state we found that the sign reversal of the Hall voltage in high magnetic field $H_{c1} << H < H_{c2}$ appears with a sign change of the transversal voltage at very low field $H_{c1} < H << H_{c2}$ at the same temperature. These facts confirms the model [4] which based on the idea, that the transversal electric field can arise from two distinct mechanism, i.e. due to the normal Hall effect in vortex cores and the Magnus force on the body of the moving vortex. This Magnus force also exists in neutral superfluids and does not depend on magnetic field. Recent calculation [5] of the Magnus force within the time dependent Ginsburg Landau (TDGL) theory can lead to sign change of the Hall voltage. In the vortex glass state the surprising result was found that the longitudinal voltage starts at a much lower critical current value than the Hall voltage. Similar result was obtained for the 2D pinned electron system (Magnetically Induced Wigner Crystal) by a group in Saclay [6]. They worked out a simple model for these two similar systems with the contribution of one of the authors. The value of the critical current calculated by the model is lower than the experimental one. Probably the planar defects in the high-T_c superconducting crystal present an anisotropic barrier for moving vortices and this fact is not included in the model.

References

† Research Institute for Solid State Physics, Budapest, Hungary

1. K. Kroto et al., Solid State Commun. **18**, 1081 (1976)
2. S.M. Artemenko et al., Phys.Lett.A **138**, 428 (1989)
3. S.J. Hagen et al., Phys.Rev.B **43**, 6246 (1991)
4. A.T. Dorsey, Phys.Rev.B **46**, 8376 (1992)
5. N.B. Kopnin et al., J. Low Temp. Phys. **90**, 1 (1993)
6. F.Perruchot et al., to be published

Time and spatial correlations in voltages generated by transport current in HTSC materials

S. Mészáros, K. Vad, N. Hegman, G. Halász and B. Sas†

Sign reversal of Hall voltage in superconducting state was observed in polycrystalline and single crystal HTSC materials near T_c and several models have been suggested for explanation. More detailed experimantal information on the sign reversal was obtained by measuring the function $V_i = f_i(I, B, T)$ where V_i is the voltage observed at a defined pair of contacts, I is the transport current, B is the static magnetic field and T is the temperature. This function can depend also on the distance of the contacts and their position relative to the current direction. Two types of samples were used in our experiments: BiSrCaCuO single crystals and Bi(Pb)SrCaCuO screen printed films. A pair of current and three pairs of voltage contacts were prepared and used. A detailed map of the sign change region in the T-B-I space was done in the temperature range of 5 K up to 200 K and magnetic field up to 6 T. Fluctuating components of voltages were analyzed; auto- and cross correlation function, probability density function and power spectral densities were calculated. Our results show, that sign change in transversal voltage is a universal feature which exists both in grain boundary junction dominated systems and single crystals in states with zero and nonzero critical currents for a rather large temperature and magnetic field region. The fluctuating components of the voltages show that for screen-printed films the voltage fluctuations have substantial spatial correlation with a correlation length of some mm. The correlation length depends on the state of the sample. No long term correlation was observed in the displaced linear branch region of screen printed films. For single crystals no spatial correlation was observed for contacts separated by 0.5 mm. The voltage fluctuations have non-Gaussian PDF and peculiar spetral distribution indicating chaotic vortex motion.

References

† Research Institute for Solid State Physics, Budapest, Hungary

1. S. Mészáros, K. Vad, G. Halász, N. Hegman, B. Sas and B. Keszei, Physica C **235-240**, 3121 (1994)

Modelling of Electron Scattering in Thin Manganese Films on Silicon by Monte Carlo Methods

K. Tőkési, A. Némethy, L. Kövér, D. Varga and T. Mukoyama[a]

[a]Division of States and Structures, Institute for Chemical Research, Kyoto University, Uji, Kyoto, 611 Japan

The electron energy distribution of the backscattered electrons from manganese films deposited on silicon substrate was studied. The Monte Carlo technique was used to simulate the backscattered electron energy distributions and these were compared with the measured reflected electron spectra.

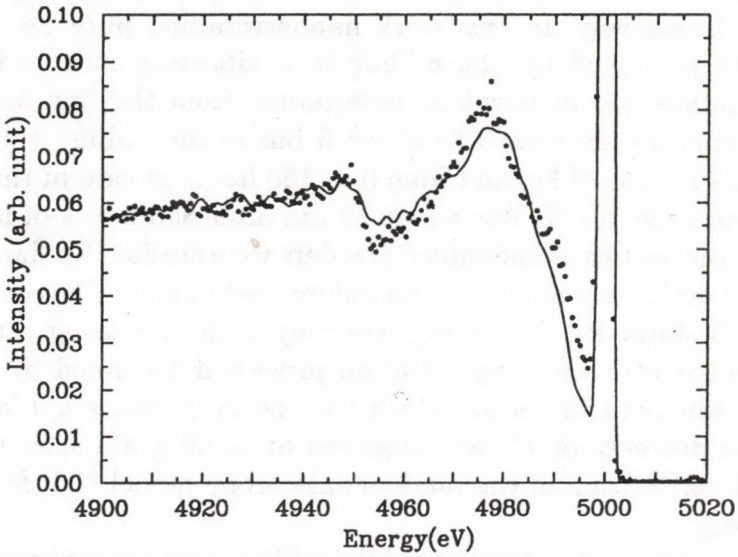


Figure 1. Backscattered electron spectra of the thin manganese films on silicon near the elastic peak. Dotted line: experimental result, solid line: calculated spectrum (the spectrum was corrected for the finite .energy resolution:. $\Delta E/E = 0.035\%$ at $E_p = 5$ *keV*

It is confirmed that the backscattered electron energy distribution calculated using the Monte Carlo simulation method can reproduce well the fine structures in the measured high energy spectrum near the elastic peak in the case of manganese films deposited on silicon substrate samples (Fig. 1.).

In addition, the comparison of the energy loss function, introduced into the MC simulation procedures, with that obtained from the simulated spectrum (by applying the method of Tougaard [1] for evaluating of REELS spectra), can provide information both for the validity of the assumptions concerned with the method and for the approximations used in the simulation.

References

1. S. Tougaard, Surface Interface Anal. **11** (1988) 453

Magnetic Properties and Mössbauer Effect of Nanocrystalline Fe, Ni and Fe(Si) Alloys

S. Szabó [1], L. Daróczi [1], I. Brovko [2], M. Kis-Varga,

D.L. Beke [1] and Gy. Posgay [1]

[1]Department of Solid State Physics, L. Kossuth University,
4010 Debrecen, P.O. Box 2., Hungary
[2]Department of Experimental Physics, P. J. Safárik University,
Faculty of Sciences, Park Angelinum 9, 041 54 Kosice, Slovakia

The magnetic properties of nanocrystalline materials prepared by different ways are studied intensively. In this work nanocrystalline pure Fe, Ni and Fe-9at%Si alloys were produced by ball milling in a vibratory mill under vacuum. The average crystallite size of powders, determined from the line broadening of X-ray diffraction spectra, decreased to about 6 nm as the milling time increased from 0 to 380 hours in case of Fe, and from 0 to 150 hours in case of the Fe-9at%Si alloy. The final grain size for Ni was about 12 nm after 350 hours of milling.

The magnetic properties of ball milled powders were studied by the Barkhausen noise measurement technique and conventional magnetometry. The coercivity (H_c) for both Fe and Ni showed a decreasing tendency with increasing grain size (d). This is in accordance with the magnetization process determined by the domain wall pinning at grain boundaries for which the theory predicts a 1/d law [1]. In case of Ni a sharp decrease of H_c was observed at small grain sizes which is the first experimental verification of the random anisotropy model [2,3] for ball milled elementary powders.

The Mössbauer spectra as a function of the milling time were measured at room temperature, and well detectable changes were observed due to grain boundaries at small grain sizes (<10 nm). From the Mössbauer measurements we can also conclude that at the end of the milling process the average saturation magnetization of the nanocrystalline Fe is about 98% of the saturation magnetization of the bulk. This is in good agreement with [4]. Similar results were obtained for ball milled Ni from direct saturation magnetization measurements.

References

1. J. Crangle, Solid state magnetism, p.195, Edward Arnold (1991)
2. G. Herzer, INTERMAG 90 Conference, Brighton, UK, paper AD.01
3. R. Alben, J.J. Becker, M.C. Chi, J. Appl. Phys. **49**(3) (1978) 1653
4. L. Daróczi et al, Nanostructured Materials, **2** (1993) 515

The $^{nat}C(^3He,2\alpha)^7Be$ and $^9Be(^3He,\alpha n)^7Be$ Reactions and Applications for Wear Measurements[1]

F. Ditrói, S. Takács, F. Tárkányi, I. Mahunka

Kapton ($C_{22}H_{10}O_5N_2$) and beryllium samples were irradiated with a 28 MeV ^3He beam in order to determine the cross-section of the above reactions by using the stacked-foil technique. Stacks of Kapton-Al and Be-Al foil-pairs were irradiated for investigation of the recoil-implantation of the ^7Be into a depth of a few micrometers and to determine the implanted activity as the function of the bombarding energy. With this method the wear of such materials can be measured which do not contain a suitable element for charged particle activation.

The ^7Be radioisotope is a comfortable tracer for the purposes of TLA (Thin Layer Activation) and wear measurements [1]. For the correct calculations it is essential to know the exact cross-section of the nuclear reactions in question. Among others the $^{nat}C(^3He,2\alpha)^7Be$ and the $^9Be(^3He,\alpha n)^7Be$ nuclear reactions can be effectively used for the production of the ^7Be isotope [2,3]. When the matrix in question contains the target material of the chosen reaction (C, Be or B) in percentage quantities, then the proper reaction can easily be chosen.

The EOB (End of Bombardment) activities were determined for each foil. The cross section data for the foil was derived from the yield of the foil. The mean energy in the foil was taken as the energy belonging to the calculated cross-section. The calculated natural cross-section of the $^{nat}C(^3He,x)^7Be$ and the $^9Be(^3He,\alpha n)^7Be$ nuclear reactions with their errors are plotted on Figures 1. and 2. respectively. Where available, the cross section data taken from the literature were also plotted in the same figure. A smooth curve was also fitted on the experimental points. In the case of the $^{nat}C(^3He,x)^7Be$ reaction our measurement agrees partly with that of Albert et al., Mikumo et al. and Cochran et al. [2,4,5], but there is about 30% disagreement between the different results from the literature and also with our measurements.

The activity in every foil (both in target and in catcher foils) was calculated versus the mean bombarding energy in the foil. At higher energies the ^7Be can also be produced from ^{27}Al with very low yield, and must be taken into account in the case of the catcher foils. The cross section of this reaction is about 0.5 mbarn at 29 MeV, so that its contribution is negligible compared even with the implantation. It is also important, when the direct beam can hit the surface to be implanted, to avoid radiation damage from the bombarding beam. The ratio of the produced and implanted activities for both investigated reactions was also determined.

1. L. Vasváry, F. Ditrói, S. Takács, Z. Szabó, J. Szűcs, J. Kundrák, Nucl. Instr. Meth. B85 (1994) 255
2. P. Albert, G. Blondiaux, J.L. Debrun, A. Giovagnoli, M. Valladon, Handbook of Nuclear Activation Data, Technical Report Series No. 273, Vienna, 1987
3. F. Ditrói, A. Fenyvesi, S. Takács, F. Tárkányi, J. Bergman, S.-J. Heselius, O. Solin Proc., Int. Conf. on Nuclear Data for Science and Technology, 9-13 May, 1994, Gatlinburg, Tennessee, USA
4. T. Mikumo, R. Seki, Y. Tagishi, M. Furukawa, H. Yamaguchi, Physics Letters 23(10) (1966) 586
5. D.R.F. Cochran, J.D. Knight, Physical Review 128(1) (1962) 1281

[1]Partly supported by the IAEA

An analytical model for insample Compton scattering of fluorescent X-rays

G. Kalinka

The importance of Compton scattering of fluorescent X-rays inside the the sample in XRF analysis has only recently been emphasized [1]. An elegant method for the description of single and multiple photon interactions has been developed by Fernandez [2]. Although this formalism is rather general, it is equally complex, and limited to only infinitely thick samples.

The method presented here, accounting only for the insample scattering, gives analytical expressions for arbitrary sample thickness, but alas, only for the case of $\Psi_d = 90°$ detection angle (Fig.1.). For an infinitely thick sample s the Compton tail distribution $g_{s,i}$, normalised to the intensity of the fluorescent line i, can be given as

$$2\pi \left[\frac{d\sigma(\Theta)}{d\Omega}\right]_{s,i} \frac{\sin\Theta\left(1+\frac{\mu_{s,i}}{\mu_{s,0}}\sin\Psi_0\right)}{\mu_{s,i}-\mu_{s,c}(\Theta)\cos\Theta}\left[\frac{1}{1+\frac{\mu_{s,c}(\Theta)}{\mu_{s,0}}\sin\Psi_0}-\frac{U(\pi/2-\Theta)}{1+\frac{\mu_{s,i}\sin\Psi_0}{\mu_{s,0}\cos\Theta}}\right],$$

where U is the unitary step function.

For the sake of correctness, the effect of the electron momentum distribution on the Compton process has also been taken into account [3].

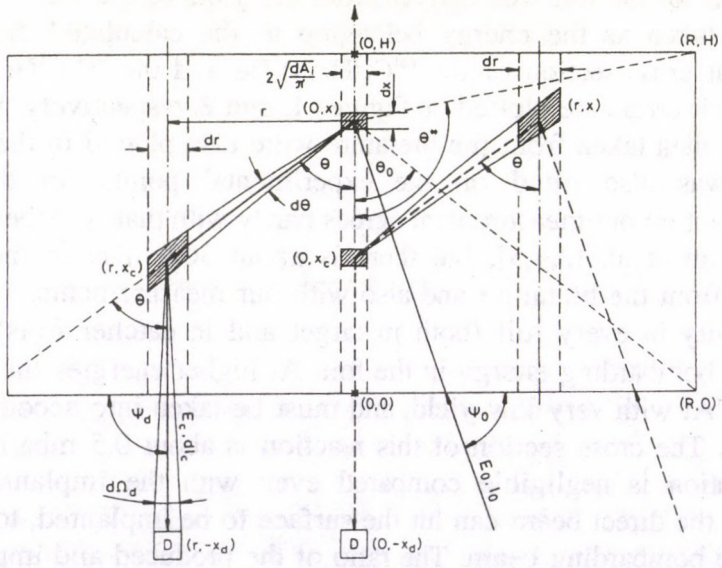


Fig. 1. Sketch to the derivation of the insample scattered Compton intensity.

1. M. Kis-Varga and J. Végh, X-Ray Spectrom. **22** (1993) 166
2. J.E. Fernandez, J.H. Hubbel, A.L. Hanson and L.V. Spencer, Rad. Phys. Chem. **41** (1993) 579, and references therein
3. G. Kalinka, to be published

EARTH AND COSMIC SCIENCES,

ENVIRONMENTAL RESEARCH

Determination of Radon and Radium Content of Water Samples by SSNTD Technique

J. Hakl, I. Hunyadi, K.Varga* and I. Csige

* Bessenyei György Teacher's Training College, H-4401 Nyíregyháza, Pf.166, Hungary

The basic idea is to immerse and expose a specially sealed small volume radon monitor into water. The radon activity content of natural waters consist of radium bounded (C_{Ra}) and unsupported (C_u) parts. Sealing a sample in the field (1st experiment) the temporal variation of radon concentration in the water is $C(t)=C_{Ra}+C_u e^{-\lambda t}$. After the first exposure the sample is degassed and then sealed again. The variation of radon concentration in this case is $C(t)=C_{Ra}(1-e^{-\lambda t})$ (2nd experiment). The radon concentration in the measuring volume (C_v) of the immersed and rubber sealed radon detector can be described as:

$$\frac{dC_v(t)}{dt} = -\lambda C_v(t) + \gamma(\eta^{-1}C(t) - C_v(t)) \qquad (1)$$

where λ is the decay constant of radon, γ is a characteristic factor for the foil-detector system and η is the partition coefficient of radon between water and air phases. In equation (1) we assumed, that the source term is proportional to the concentration difference and the radon concentration in water is uniform. For thin foils and properly mixed samples these assumptions are valid. Applying thin foils with high radon permeability we get $\gamma >> \lambda$. In this case $C \approx \eta C_v$ and C_{Ra} and C_u can be obtained from the following formulas:

$$C_{Ra} = \frac{\eta}{S}\rho_2 \frac{\lambda}{\lambda T_2 + e^{-\lambda T_2} - 1} \qquad (2)$$

and

$$C_u = \left(\frac{\eta}{S}\rho_1 - T_1 C_{Ra}\right)\frac{\lambda}{1 - e^{-\lambda T_1}}, \qquad (3)$$

where S is the registration sensitivity of the radon monitor, ρ_1 and ρ_2 are track densities and T_1 and T_2 exposure times.

We have used and tested the glass vessel method in two large series of measurements. The first series was performed as part of a general study of deep thermal waters of NE part of the Great Hungarian Plain. In this case only the radium content of waters was determined. The mean value was found to be 250 mBq/l. The second series of application was performed during in situ field measurements in studying four karstic aquifers in Spain and Croatia. In this case both radon and radium content of waters were determined. The lowest radon concentration was found in surface (0.02 Bq/l) whereas the others were in the range 1.7-13.9 Bq/l.

This work was supported in part by the National Scientific Research Fund No. 3005.

Radon Doses Received in Speleotherapy Courses

I. Hunyadi, I. Csige, G. Géczy* and J. Hakl

* Eötvös Loránt Univ. Dept. of Phys. Geog. H-1083 Budapest, Ludovika tér 2, Hungary

The Szemlő-hegy cave has been open for the public since 1986, and since 1990 tourists share it with patients. Based on positive reflections on the first two years experience in curing asthmatic and other allergic complaints, the cave was established as a therapeutic cave in 1992.

We have performed radon monitoring with etch track type radon monitors using one month integrating times. We have calculated the doses from inhaled radon and its decay products (according to the proposals of the ICRP 50) for participants in speleotherapy in the cave. Fig. 1 shows the differential and cumulative probability distributions of effective dose equivalents received by individual patients. It shows that about 5-10% of patients received more than 5 mSv of effective dose equivalent during their cures, which value is a suggested annual limit of exposure of general population from natural background. Therefore, we propose to evaluate and show the radon doses of the patients in their medical records in the future. We have also estimated the annual effective dose equivalent from radon and its decay products for the staff members of speleotherapeutic treatments and found that it is probably in the range between 15 and 40 mSv/year. We suggest continuous monitoring of their doses (preferably with personal radon dose meters) making possible to prevent them from receiving higher doses than reasonably acceptable.

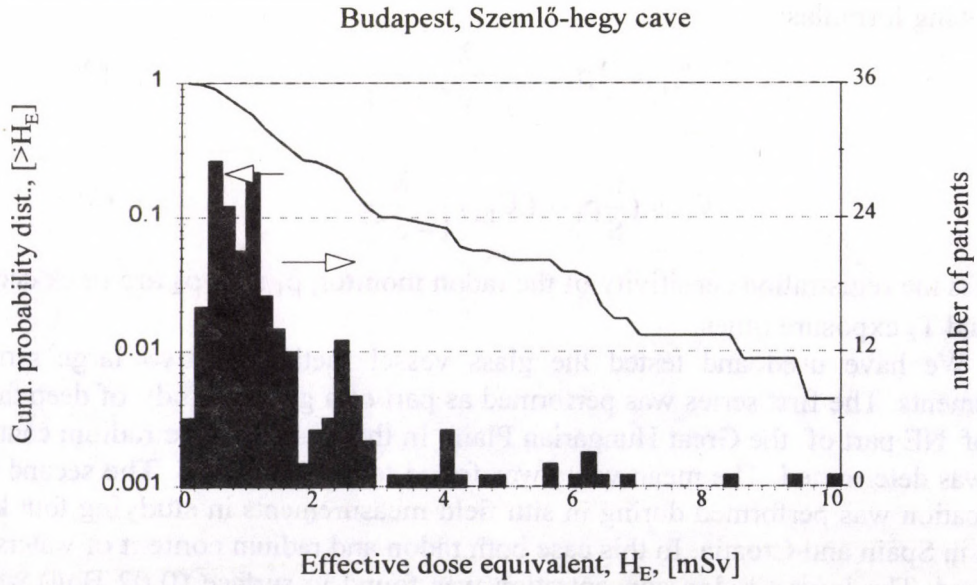


Fig. 1. Differential and cumulative probability distributions of effective dose equivalents received by patients of speleotherapeutic courses in the Szemlő-hegy cave during the period of 1990-1992.

This work was supported by the National Scientific Research Fund, number 3005.

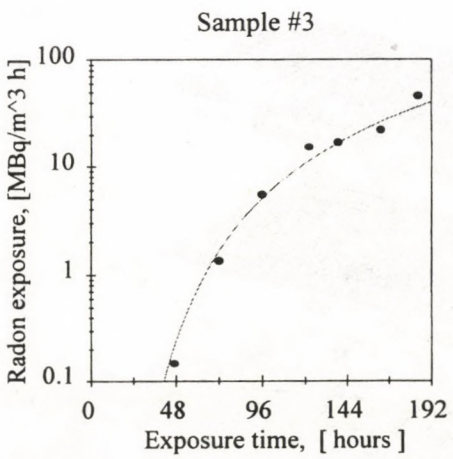
Measurement of Diffusion Coefficient of Radon in Porous Media with Etched Track Radon Monitors

I. Csige, J. Hakl and I. Lakatos*

* Research Laboratory for Mining Chemistry of the Hungarian Academy of Sciences, 3515 Miskolc-Egyetemváros, Pf. 2, Hungary

We have developed two closely related methods to measure effective diffusion coefficient of radon in porous medium using etch track type radon monitors. In the first method a series of samples with identical thicknesses were exposed to constant radon concentration for different exposure times. In the second method samples with different thicknesses were exposed to identical radon exposure. The samples had cylindrical shape with non-permeable walls on the lateral surface. They were exposed at one base side while a measuring volume was shaped on the opposite base side. We used etch track type radon monitors to measure the radon exposure on both the exposure and the measuring sides. We have used a computer code to model the transport and found the effective diffusion coefficient by changing its value in the code to find the best fit of model calculation to experimental data.

Figs. 1. and 2. show one-one examples for both methods developed. In the first method we applied about 20 $MBqm^{-3}$ in the second method about 0.6 $MBqm^{-3}$ inlet radon activity concentration. The thickness of samples was 2 cm in the first method and the exposure time was 144 hours in the second method. All parameters but effective diffusion coefficient of sample filling materials were known from independent measurements. The solid curves on figures are obtained from model calculations with diffusion coefficients giving the best fit to experimental data.



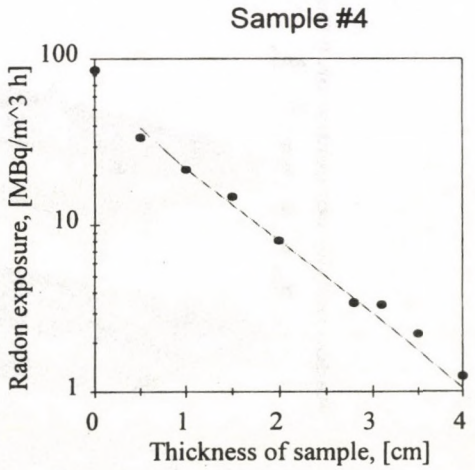


Fig. 1 and 2. Radon exposures obtained in the measuring volume of samples.

Radon Survey of Soil Gas and Ground Water in a Hungarian Village

A. Vásárhelyi, I. Csige, J. Hakl and I. Hunyadi

Radon-222, because of its harmful effects to the human body, is treated mostly from the point of view of health physics. However radon presents proprieties that makes it very suitable for being used as a tracer gas. Its nature of noble gas results in a high mobility, and being α-radioactive it is easily detectable. The migration of radon in porous media - a slower diffusion through the media, and a faster convection along the cracks - is highly dependent on the porosity and on the structure of that media.

In our survey of 1993 summer we have determined spatial distribution of radon in the ground water and in soil gas of Mátraderecske, a village situated at the northern part of the Mátra mountain, where a few km wide seismically active zone crosses the North Hungarian Central Range. In order to determine the radon activity concentration in ground water and in soil gas we have used small volume radon detectors with SSNTD, placed 80 cm beneath the water level in drilled wells, and in 30 cm deep holes drilled in the vicinity of the wells. The 130 sampling places were chosen within an area of approximately 1.5 km^2, selecting houses where drilled wells were found. The results are presented in Fig.1. The similar structure of the two maps reveals that the radon in subsurface soil gas and the radon in ground water are interrelated. Higher radon levels are grouped along two main directions (approximately N-E and E-W), indicating inhomogenities in the geological structure - cracks, where convection of radon (and of other upflowing gases) can take place.

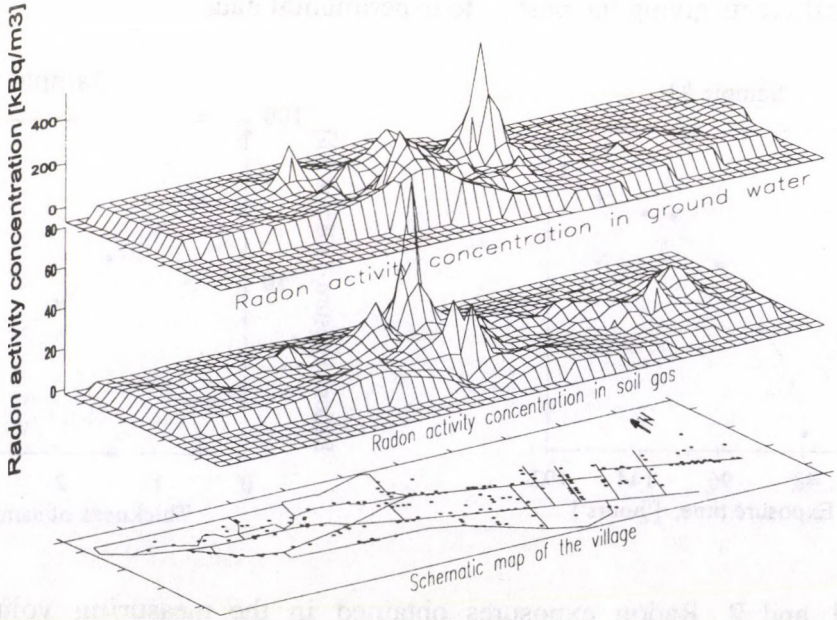


Fig. 1. Spatial distribution of radon in soil gas and in ground water

This work was supported by the National Scientific Research Fund, No. 7603.

Preliminary Rb-Sr dating of the Velence granite

A. Kovách and E. Svingor

The Hercynian age of the postorogenic, S-type granite of the Velence Mountains located in the axis of the Central Mountain Range in the Transdanubian part of Hungary has been long ago established [1] and proved on a geological basis. The actual age of emplacement, however, could not be established exactly. K-Ar studies [2] supplied scattering ages, reflecting the effect of secondary processes including the (local) intrusion of Mesozoic dyke rocks, the effect of Neogene volcanism in the Northern parts of the mountain. The possible effect of low-grade, early Alpine metamorphism cannot be excluded either. The upper limit of the K-Ar ages around 290 Ma, however, seemed to approximate the true emplacement age of the granite.

In order to obtain independent information on the emplacement age of the granite, Rb/Sr analyses have been carried out on 14 total rock samples as well as on 8 biotites. In the calculation of a total rock isochron 5 samples have been excluded for different reasons (obvious presence of secondary effects, excess contribution to the summed RMS deviation, etc.) The total rock isochron obtained this way yielded an age of 286±6 Ma with an initial $^{87}Sr/^{86}Sr$ ratio of 0.7096±0.0004. At the same time, the weighted average of the individual biotite ages was 287±8 Ma with an average initial ratio of 0.7084±0.0015. The agreement between the total rock isochron age and the average of the single biotite ages points to the rapid emergence of the granitic mass following its emplacement.

Thanks are due to Dr. I. Horváth (Hung. Geol. Survey, Budapest) for providing some of the samples used in the present study. A detailed report on the measurements will be published elsewhere [3].

References

[1] Jantsky, B., Geology of the Velence Mountains [in Hungarian]. Geol. Hung., Ser. Geol. **10** (1957) pp. 1-139.

[2] Balogh, K., Árva-Soós, E. and Buda, Gy., Chronology of granitoid and metamorphic rocks of Transdanubia (Hungary). An. Inst. Geol. Geophys. (Bucharest) **61** (1983) 359.

[3] Buda, Gy., Kovách, A. and Svingor, E., to be published.

Geochronological studies with the K/Ar method in 1994

K. Balogh, E. Árva-Sós, Z. Pécskay

Pargasitic hornblende from the Meatiq metagabbro (Eastern Desert, Egypt) resulted 599 ± 32 Ma (Cooperation: El-Minya Univ. (1)). In SW Sinai the older series of diorite-tonalite-granodiorite resulted ages from 653 to 567 Ma, the age of younger assemblages (monzogranite-syenogranite-alkali feldspar granite) spreads from 602 to 562 Ma (2). (C: Univ. of Zagazig).

Lower Cretaceous ages were measured on alkaline magmatic rocks in the Mecsek Mts. (C: Eötvös Univ., Budapest (3)), and Middle Triassic age was obtained for some volcanic rocks of the Budva area, Yugoslavia (C: Univ. of Belgrade, Eötvös Univ. (4)). In the Slavonija-Srijem Depression (Croatia) 4 groups of magmatic rocks has been distinguished ranging in age from Senonian to Badenian (C: Geol. Inst. Zagreb (5)).

Ages from 2.8 to 0.2 Ma were established for the South Harghita, Romania (C: Geol. Inst. Bucharest, (6)). In the Gutai Mts. andesitic volcanism started near the Badenian-Sarmatian boundary and ended in the Pannonian about 9 Ma ago; in this area 7-8 Ma age was measured for the youngest, basaltic phase of volcanic activity (C: CUART S.A., Baia Mare (7-8)). 24-19 Ma ages were obtained on the basic volcanics of the Moesian Platform, Bulgaria. (C: Geol. Inst. Bolg. Acad. Sci., Sofia, (9)).

K/Ar dating of the alkali olivine basalt of Somoska was unsuccessful previously, due to the heterogenous isotopic composition of its initial argon. By selecting fractions of uniform and low atmospheric argon concentrations, concordant and reliable isochron ages of 4.06 Ma and 4.08 Ma were obtained (C: GUDS, Bratislava, (10)). Austrian-Subhercynian ages were determined for the oxidation of manganese ores at Urkút, Hungary (C: József Univ., Szeged, Lab. Geochem. Res. Hung. Acad. Sci., Budapest, (11)).

In the W-Mecsek Mts. members of the Lower and Middle Rhyolite Tuffs were distinguished (C: Mecsek Uranium Ore Mining Co., Pécs). K/Ar ages on the crystalline basement of the Great Hungarian Plane reflect the time of Hercynian and Alpine (Austrian phase) orogenies. Feldspars from the Ditró Massif resulted Lower Cretaceous ages, while Triassic ages were obtained on amphiboles from the same rocks. These results are interpreted in terms of a slow uplift of the area. (C: József Univ., Szeged). Part of mylonites in the Mecsek Mts. was formed during the Hercynian orogeny (C: Eötvös Univ.).

It was demonstrated that volcanic layers among the Tertiary sediments in the Apennines did not originate from the area of the Adriatic sea. The gabbro of the Jabuka Islet intruded in the Middle Triassic, predating the oceanic rift-stage

leading to the opening of the Western Tethys (C: Univ Urbino, Inst. Miner. Petr. Econ. Geol., Zagreb). In the Sopron Mts. biotites from the biotite-amphibolite-schists reserved Hercynian ages, while mineral ages from the gneiss suggest a fast uplift during the Upper Cretaceous (C: Geochem. Res. Lab. Hung. Acad. Sci.). On the basis of muscovite and K-feldspar K/Ar ages 0.30 ± 0.13 mm/year uplift rate was obtained in the Jurassic and Lower Cretaceous for the Batocina complex (Serbo-Macedonian Massif). (C: Univ. Belgrade). Dating of Miocene-Oligocene tephra layers in Sardinia was continued (C: Univ. Cagliari) and a study was started on the Lower Miocene magmatites in the Canary Islands. (C: Univ. La Laguna).

103-75 Ma ages were measured for the Cu-mineralization of the Punta del Cobre district, Chile (C: Soc. Cont. Minera Carola). The subvolcanic rocks of the Tibles Mts., East-Carpathians, resulted Pannonian (11-8 Ma) ages (C: CUART S.A., Baia Mare). The chronological study of the Miocene volcanic rocks of the Gurghiu Mts. was continued (C: Geol. Inst. Bucharest, Univ. Madrid).

References

1. M. El Mahallawi, E. Árva-Sós, E.: Acta Miner. Petrogr., Szeged, **34**(1993)71
2. A. M. Abdel-Karim, E. Árva-Sós: Proc. 3rd Conf. Sinai Develop., Ismailia, (1992)261
3. Sz. Harangi, E. Árva-Sós(1993): Földt. Közl. **123**(1993)129
4. I. Bilik, V. Knezevic, E. Árva-Sós, M. Jánosi, S. Karamata: Ann. Geol. Peninsula Balkan. **57/1** (1993)215
5. J. Pamic, Z. Pécskay: Nafta (Zagreb) **45/7**(1994)331
6. A. Szakács, I. Seghedi, Z. Pécskay: Rev. Roum. Geol., **37**(1993)21
7. Z. Pécskay, O. Edelstein, M. Kovács, A. Bernad, M. Crihan: Geol. Carp. **45**(1994)357
8. O. Edelstein, Z. Pécskay, M. Kovács, A. Bernad, M. Crihan, R. Micle: Rev. Roum. Geol., **37**(1993)37
9. Y. Yanev, Z. Pécskay, P. Lilov (1993): Rev. Bulg. Geol. Soc. **54** (1993)71
10. K. Balogh, D. Vass, L. Ravasz-Baranyai: Geol. Carp. **45/2**(1994)97
11. Gy. Grasselly, K. Balogh, M. Tóth, M. Polgári: Geol. Carp., **45/6**(1994)365

Kerogen $\delta^{13}C$ records a rapid Latest Oligocene decrease of atmospheric CO_2 synchronous of a retreat of Antarctic ice mass

I. Vető[1], E. Hertelendi, CS. Sajgó[2]

[1] Hungarian Geological Survey, 1143 Budapest, Stefánia út 14, Hungary
[2] Laboratory for Geochemical Research of the HAS, 1112 Budapest, Budaőrsi út 45

Recent studies have documented that carbon isotopic ratio of bulk sedimentary organic matter of aquatic origin can be used as a proxy for evolution of atmospheric CO_2 level in Holocene-Late Pleistocene time [1]. The enrichment of marine organic matter in ^{13}C occurred somewhere in the Eocene-Early Miocene time interval can be similarly interpreted as a reflection of a contemporaneous decrease of atmospheric CO_2 level. Here we present isotope and organic geochemical analysis of an Oligocene-Lower Miocene mud section from the ODP 682A Hole (Peru Margin). We find that the $\delta^{13}C$ of the predominantly marine kerogen shows an increase of about 4 permil for the Latest Oligocene (Fig. 1). Using relationship found between planktonic $\delta^{13}C_{org}$ and dissolved CO_2 in present-day oceans a 170-190 ppm drop in atmospheric CO_2 was calculated for the last 1 My of the Oligocene. This rapid decrease of atmospheric CO_2 level was synchronous with a decrease of Antarctic ice cap.

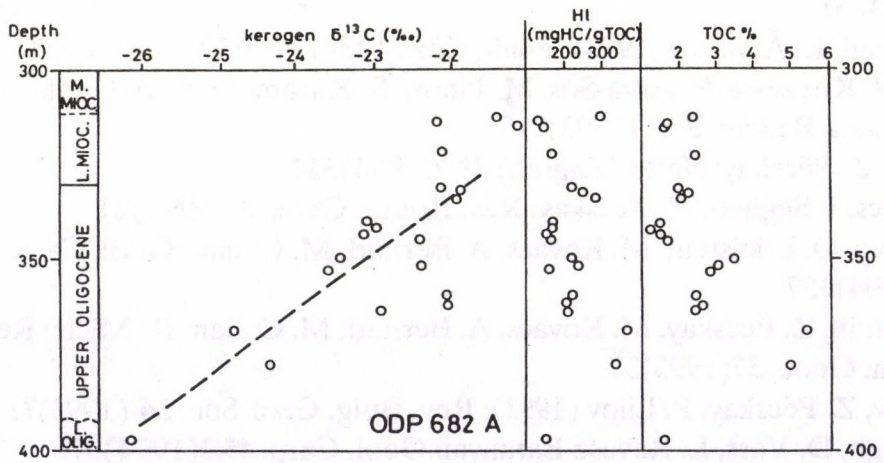


Fig. 1. Plot of some organic geochemical and isotopic parameters vs depth in the Oligocene-Lower Miocene section of the ODP 682A Hole.

References

1. E. Hertelendi, I. Vető: The marine photosynthetic carbon isotopic fractionation remained constant during the Early Oligocene. Palaeogeography, Palaeoclimatology, Palaeoecology 83, 333, (1991).

^{14}C chronology of the Neolitic in Eastern Hungary

E. Hertelendi, N. Kalicz[1], P. Raczky[2], F. Horváth[3], M. Veres, I. Futó, É. Svingor, L. Bartosiewicz[1]

[1]Archaeological Institute of the HAS, H-1250 Budapest, Úri utca 49, Hungary
[2]Eötvös Loránd University, Department of Archaeology, H-1364 Budapest, P.O.Box 107, Hungary
[3]Móra Ferenc Múzeum, H-6701 Szeged, Roosevelt tér 1-3, Hungary

Neolithic cultures from Eastern Hungary were assigned to ten gross groups. Radiocarbon dates available for this study were classified within their respective groups (Fig. 1). Using 261 calibrated radiocarbon dates from the Great Hungarian Plain a series of cumulative probability densitograms were constructed..

Our investigations shed light on a number of archaeological phenomena [1]:

1/ The beginnings of the Neolithic Period in Hungary may be dated to the turn of the 7^{th}-6^{th} millennia BC while the end of the 5^{th} millennium BC most probably marks the end of this period. The entire life span of the Neolithic may be estimated as 1700 years in Hungary. Since, however, no radiocarbon dates are known for the earliest Neolithic in Hungary, it is possible that the actual beginning of this period may be found some time within the 7^{th} millennium BC. This would indicate that the Neolithic period lasted as long as 2000 years.

2/ Data available at present suggest that Neolithic cultures, previously regarded as completely sequential, often overlap with each other. This is an indication of their at least partially parallel existence..

3/ Within the aforementioned chronological framework, the most probable time interval for the Early Neolithic ranges between 6100/6000 to 5600/5500 BC. The Middle Neolithic most probably occurred between 5600/5500 and 4900/4800 BC. The most likely time period for the Late Neolithic must have been between 4900/4800 and 4400/4300 BC. Within this chronological model, the estimated 400-500 years life expectancy of the Late Neolithic tell settlements obtained by traditional typochronological methods is also confirmed by the calculation of radiocarbon data. Radiocarbon dates obtained for the end of the Late Neolithic are consonant with the previously established absolute dates of the Early Copper Age.

Phase	Culture or culture group	Number of samples	Confidence interval 68.3%	95.4%
Early	Körös	14	5899-5620 5599-5435	6054-5212
	Late Körös (Protovinča)	14	5780-5254	5962-5038
Middle	Early Alföld Linear Pottery (Szatmár 2)	1	5576-5542 5529-5474	5594-5439
	Vinča	6	5442-5063	5480-4799
	Middle Alföld Linear Pottery (classical)	5	5345-5065	5444-4720
	Late Alföld Linear Pottery (Tiszadob)	6	5288-4970	5443-4902
	Szakálhát - Esztár - Bükk	30	5283-4940	5341-4752
Late	Transitional formation phase of the Tisza culture	46	5082-4760	5273-4451
	Tisza - Herpály - Csöszhalom	134	4836-4494	5061-4335
	Prototiszapolgár	5	4523-4248	4704-4223

Fig. 1. Chronology of Neolithic cultures in Hungary

References

1. E. Hertelendi, N. Kalicz, P. Raczky, F. Horváth, M. Veres, I. Futó, A. Figler and L. Bartosiewicz: Re-evaluation of the Neolithic in Eastern Hungary based on calibrated radiocarbon dates. Proceedings of the 15th International Radiocarbon Conference, Glasgow, Scotland, August 15th-19th 1994. Editors: A. Long and R. S. Kra

Dose Contribution of ^{14}C in the vicinity of Paks NPP

E. Hertelendi, GY. Uchrin[1], I. Barnabás[2], P. Ormai[2], G. Volent[2], M. Veres, É. Svingor, I. Futó

[1]Institute of Isotopes of the HAS; Budapest, Hungary, H-1525 P.O.Box 77
[2]Paks Nuclear Power Plant; Paks, Hungary, H-7031 P.O.Box 71

The normalized total ^{14}C release of Paks NPP is equal to 0.80 $TBqGWe^{-1}y^{-1}$ [1]. Exactly 94% of the total radiocarbon discharge is apportioned to hydrocarbons and the remaining fraction, 6% to CO_2. ^{14}C release into the environment has local and global radiological impact, too. The dose contribution due to elevated ^{14}C concentration in the vicinity of a NPP is on the order of $1mSvy^{-1}$ depending on the type and capacity of the reactor. For PWR-type NPPs, where the $^{14}CO_2$ is only a minor fraction of the total discharge, the effective dose equivalent to individuals is negligible. The calculated maximum effective dose equivalent for the Paks NPP is 30 $nSvy^{-1}$ if only the $^{14}CO_2$ form is regarded and 0.6 $mSvy^{-1}$ when the conservative estimate takes into account the hydrocarbon form too.

It is estimated that by the year 2050 A.D., the individual dose due to reactor-derived ^{14}C will reach 1.8 $mSvy^{-1}$, which is 12% of the total dose of 15 $mSvy^{-1}$ attributed to natural ^{14}C.

The long term effects of ^{14}C discharges are estimated on the basis of collective effective dose equivalent commitment (CEDEC) from a nominal unit release (1 TBq) of ^{14}C from the nuclear industry. The UNSCEAR 1993 report gives a range between 67 and 59 man-Sv per TBq for collective effective dose per unit release. In our calculation a conservative value of 141 man-Sv per TBq was used. The CEDEC due to carbon release from the Paks NPP is calculated to be 170 man-Sv if the year 1993 is considered, and 1480 man-Sv based on the total length of the NPP's operation, 1983-1993.

These collective dose equivalent commitments will be delivered if the sum is taken to infinity and 8%, 24%, and 75% of the total dose is delivered in 100, 1 000, and 10 000 y, respectively. It is assumed that ^{14}C released other than in CO_2 form will be oxidized to this form. For the methane fraction, this is a plausible assumption because its lifetime is 7.5 year in the environment.

The estimated total release of ^{14}C, from all nuclear power operations, up to 1990 is approximately $9x10^{15}$ Bq (NCRP 1985) yielding a dose rate of 180 $nSvy^{-1}$. This value is approximately 1.5% of the dose from natural ^{14}C which amounts to only 1% of the total dose equivalent from natural background radiation.

References

1. M. Veres, E. Hertelendi, Gy. Uchrin, E. Csaba, I. Barnabás, P. Ormai, G. Volent and I. Futó: Concentration of radiocarbon and its chemical forms in gaseous effluents, environmental air, nuclear waste and primary water of a pressurized water reactor power plant in Hungary. Proceedings of the 15th International Radiocarbon Conference, Glasgow, Scotland, August 15th-19th 1994. Editors: A. Long and R. S. Kra

Aerosol Sampling and Analysis by PIXE

I. Borbély-Kiss, E. Koltay, Gy. Szabó

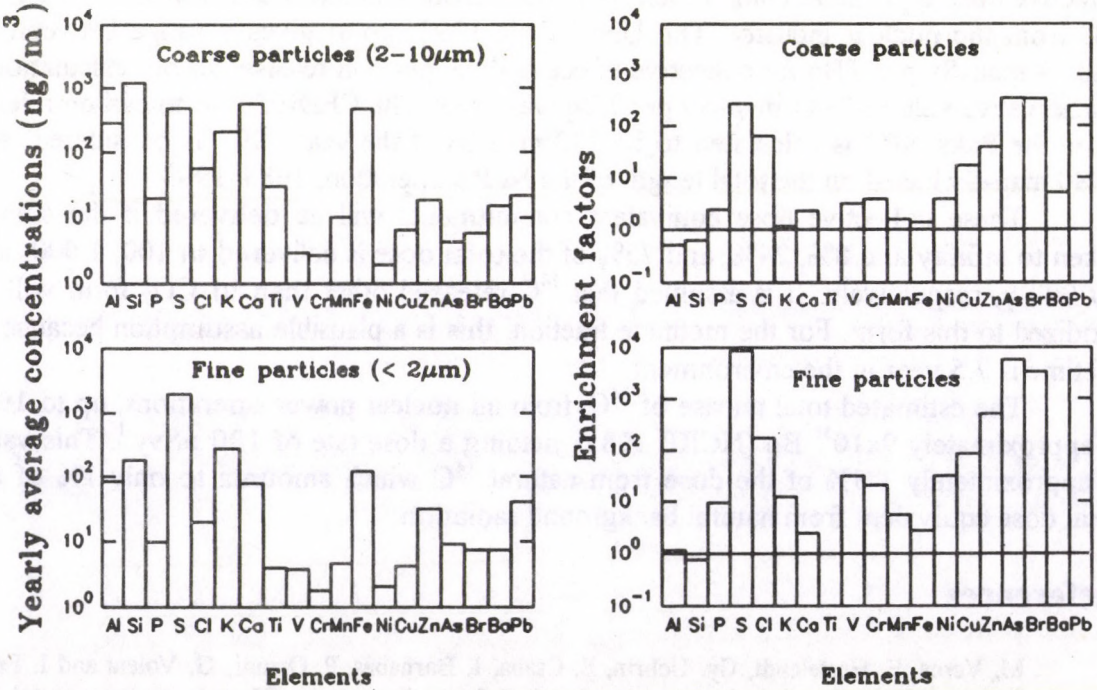
A regular aerosol sampling in ATOMKI has been continued with an integral aerosol sampler.

Sampling with a "GENT" stacked filter unit has been started in collaboration with the IAEA (CRP No.7257). In an urban sampling site (in ATOMKI) 95 coarse (the size of the aerosol particle is 2-10μm) and 95 fine (the size of the aerosol particle is $<2\mu$m) aerosol samples have been collected onto the surface of 8μm pore size and 0.4μm pore size NUCLEPORE polycarbonate membrane filter, respectively. The airborne particulate mass concentration has been determined in $\mu g/m^3$, too.

The above samples have been analyzed by PIXE and elemental concentration of Al, Si, P, S, Cl, K, Ca, Ti, V, Cr, Mn, Fe, Ni, Cu, Zn, As, Br, Ba, Pb has been calculated for each.

Yearly averages of concentrations for the elements have been calculated together with enrichment factors. The figure below shows the result. Differences between the two fractions are clearly seen.

Further statistical evaluation will be done by others, according to the CRP No.7257.



Yearly average concentrations and enrichment factors of elements, measured on aerosol samples.

BIOLOGICAL

AND

MEDICAL RESEARCH

Small Volume Water Ice Target for ^{18}F Production on a Vertical Beam-Line

I. Mahunka, L. Andó, I. Gál, T. Ido*, Z. Kovács

* CYRIC Tohoku University, Sendai, Japan.

Fluorine-18 is one of the most frequently used radioisotopes for PET studies in the medical research and diagnosis. For its production numerous methods have been elaborated, based on different types of small accelerators [1]. For routine production mostly the $^{18}O(p,n)^{18}F$ reaction is used, where the target itself is enriched [^{18}O]water. To improve the production parameters and to reduce the target cost, water [2] and carbon dioxide [3] ice target systems have also been built.

In our Cyclotron Laboratory the vertical beam-line arrangement gives a good possibility for the development of a simplified water ice target system. The target chamber, made from silver, has conical form. The cone is mounted vertically with its axis parallel to the proton beam. For the injection and outlet of the water (~120 μl) a pressured He gas transporting system is used. Simultaneously with the cooling of the cone a bubbling of the He gas through the water target is applied. In this way a thin layer of ice can be produced on the wall of the cone, which is thick enough for the 14 MeV proton beam. After the irradiation an electrical heater is used to warm the target to room temperature. In every case more than 60 % of the produced activity is found in the enriched [^{18}O]water and the remaining part can be washed out by normal water. The yield of the production of ^{18}F was measured as a function of the beam intensity up to 15 μA and it was found to be linear.

On the basis of our preliminary experiments it can be stated that the elaborated method is suitable for the routine production of ^{18}F, and the target chamber with some modification can be used on a horizontal beam-line too.

References:

[1] M. Guillaume, et al., Appl. Radiat. Isot., 42(1991)749
[2] B. J. Hughey, et al., J. Nucl. Med., 33(1992)932
[3] L. Mahmoud, et al., Appl. Radiat. Isot., 44(1993)1081

Automated production of [$^{11}CH_3$]-methionine: Synthesis of [$^{11}CH_3$]-methanol intermedier

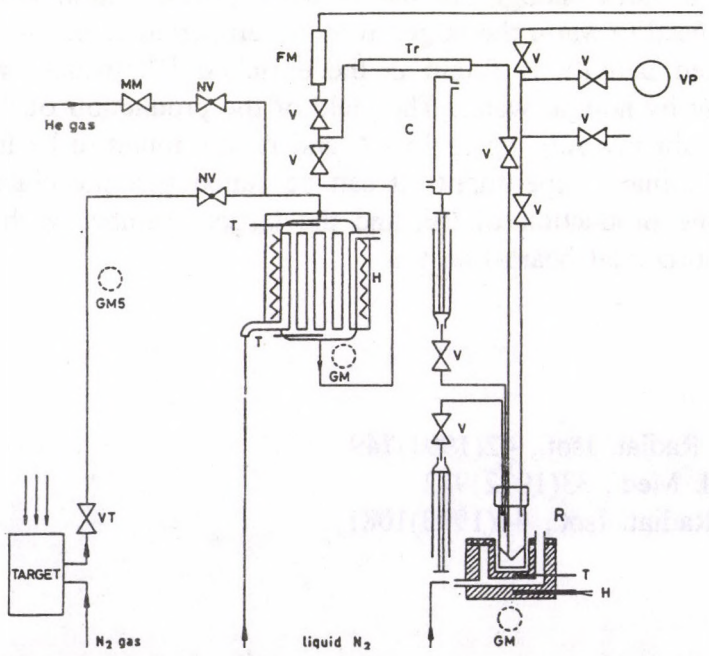
É. Sarkadi, Z. Kovács, L. Andó

The [$^{11}CH_3$]-labelled methionine is the most frequently used amino acid in oncology studies for PET (Positron Emission Tomograph).
The [$^{11}CH_3$]-methanol intermediate synthesis is a fundamental part of the [$^{11}CH_3$]-methionine production (Fig.1). The basic compound, the $^{11}CO_2$ is produced by $^{14}N_2(p,\alpha)^{11}C$ reaction in nitrogen gas contaning O_2 traces [1].

A special unit is developed to freeze out the $^{11}CO_2$ from irradiated target gas. The optimal temperature is maintained by regulated cooling with liquid N_2 and it is measured -145 °C at an optimal flow of 800 ml/min. The $^{11}CO_2$ is desorbed from the surface by warming up to 80 °C.

The $^{11}CO_2$ is introduced into a reaction vessel and reduced with $LiAlH_4$ in tetrahydrofuran. After evaporation of the solvent, it is hydrolysed by the addition of diethyleneglycol monobutyl ether containing 5% water [2]. The [$^{11}CH_3$]-methanol produced is distilled off at 140 °C with a He-flow for further steps of [$^{11}CH_3$]-methionie synthesis.

For yield measurement the [$^{11}CH_3$]-methanol intermedier is trapped in methanol. The average yield is 70 %.



C: pneumatic cilinder
H: heating element
R: reaction vessel
T: thermocouple
V: valve
FM: flow meter
GM: GM-counter
MM: manometer
NV: needle valve
Tr: trap

Fig.1.[$^{11}CH_3$]-methanol production

References

1. Z.Kovács, É.Sarkadi, L.Andó, ATOMKI Annual Report (1993) 148
2. M.Holschbach, M.Schüller, Appl.Radiat.Isot. Vol.44, No.4 (1993) 779

DEVELOPMENT OF METHODS

AND

INSTRUMENTS

Radiation Test of Parallel Plate Chambers

G. Dajkó, A. Fenyvesi, J. Molnár

Within the framework of the RD37 Project [1] of CERN (Geneva, Switzerland), we have performed gamma and neutron irradiation tests of parallel plate chambers (PPC).

A PPC is a gaseous detectors working in the avalanche mode. Between the two planar metal electrodes a very high (50-60 kV/cm) and uniform electric field can be obtained. The signal is of the order of few nanoseconds and the gains are in the range 10^2 - 10^5 [2]. The purpose of the RD37 project is the construction of PPC technique based modules of the very forward hadron calorimeter for CMS (Compact Muon Solenoid) [3] at the future LHC (Large Hadron Collider).

The intense ^{60}Co gamma source and the fast neutron irradiation facility at the MGC-20E cyclotron of the ATOMKI were used for the tests of PPCs of transverse dimensions of 5x5 cm^2 with 1.5 mm gap and filled with CO_2 gas at atmospheric pressure. The PPCs were made of metallized aluminum oxide based ceramics.

A dose rate of 1 Mrad/day was used in the case of the gamma test. The total gamma dose was 100 Mrad which is comparable to the one expected in the region of $|\eta| \approx 4.5$, after 10 years of LHC operation at the maximum. The current normalized to the gas density at the time of the measurement was constant within ± 5 %. The ratio between the gas gain before and after the irradiation, as a function of the high voltage, was 1 within ± 5 %.

Neutrons were produced by the p(18 MeV)+Be bombarding particle - target combination. The mean neutron energy was E = 3.5 MeV and a flux rate of 1.3 x 10^{10} $cm^{-2}s^{-1}$ was employed. The total neutron flux was 0.5 x 10^{16} ± 11% neutrons per cm^{-2} with an additional gamma dose of 48 ± 13% Gy. This n-flux is approximately the one expected in the above mentioned region at LHC after 5 years of operation. The result of the neutron irradiation test is shown in Fig. 1.

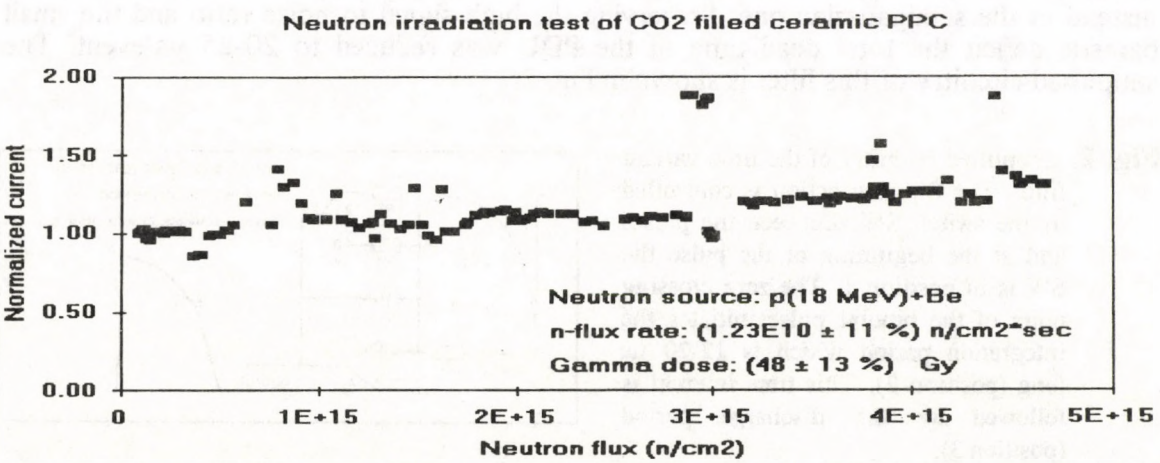


Figure 1. Measured normalized current vs. the neutron flux. The current was normalized to the starting value and to the gas density at p=1033 mbar, T=25 °C.

[1] CERN/DRDC 93-43, DRDC/P51
[2] CERN/DRDC/94-46, RD37/Status Report, January 9, 1995
[3] CERN/LHCC 93-48

Improved version of the particle discriminator unit used for identification of light charged particles

J. Gál, B.M. Nyakó, G. Kalinka, G.E. Perez, A. Kerek[a], A. Johnson[a] and T. Vass

[a]The Royal Institute of Technology, Physics Dept/Frescati-Stockholm, Sweden

Efforts were made to improve the parameters of the particle discriminator unit (PDU) developed for CsI(Tl) + PIN photo diode detector [1,2]. Taking into account the experimental conditions where the PDU will be used the low energy limit of particle discrimination and the count rate behaviour of the unit are of particular importance.

The low energy limit of the discrimination is mainly governed by the bipolar shaper applied in the unit. The time constant value, the ratio of the time constants of the high pass and low pass filter part of the shaper and the order of the low pass filter all influence the "figure of merit" of the particle discrimination. We tried to find the best bipolar shaper experimentally. The shaper shown in Fig. 1. gives near optimum results.

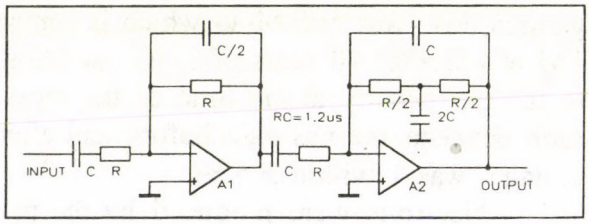


Fig. 1. Simplified circuitry of the bipolar filter.

The count rate behaviour of the PDU is determined by the dead time caused by one input event. This time interval is composed of some different parts, but the longest of them is generated by the unipolar shaper. In order to assure high signal to noise ratio and negligible ballistic deficit it is necessary as large as 10 μs shaping time constant. In the case of semigaussian shaping this means nearly 100 μs/event dead time. To reduce this dead time, in the improved version of the PDU a simple time variant shaper is used instead of the semigaussian one. Preserving the high signal to noise ratio and the small ballistic deficit the total dead time of the PDU was reduced to 20-25 μs/event. The simplified circuitry of this filter is shown in Fig. 2.

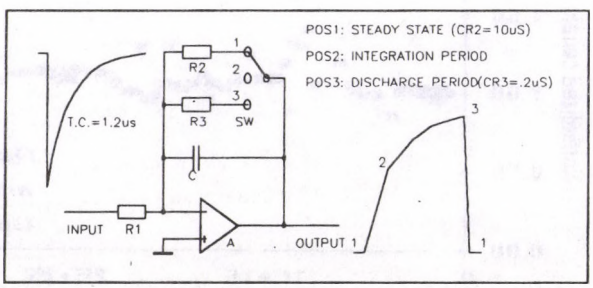


Fig. 2. Simplified circuitry of the time variant filter. The filtering action is controlled by the switch SW. Between the pulses and at the beginning of the pulse the SW is in position 1. The zero crossing point of the bipolar pulse initiates the integration period which is 12-20 μs long (position 2). This time interval is followed by the discharge period (position 3).

References

[1] J. Gál et al., ATOMKI Annual Report 1993, (1994) 142
[2] G. Kalinka et al., ATOMKI Annual Report 1993, (1994) 140

Optimisation of a small CsI(Tl) + Si pin photodiode particle detector

G. Kalinka, J. Gál, B.M. Nyakó, Z. Varga

A small CsI(Tl)+Si pin photodiode detector, as part of a 4π charged particle detector system for future EUROBALL application [1], has been optimised for maximum amplitude and resolution simultaneously, both parameters being essential for good particle discrimination too [2]. The necessary solution of an improved light collection, while keeping the amount of reflector materials at minimum to reduce particle energy loss, γ and n absorption and scattering, has been achieved by combination of a thin white underpaint and teflon tape wrapping on the detector sides (Fig.1.). Lateral amplitude inhomogeneity is reduced by coupling the 15x15x3 mm^3 scintillator via a trapezoidal light guide to the 10x10 mm^2 photodiode. The entrance surface is covered by 2.5 μm thick aluminised Mylar foil. The overall light collection efficiency is estimated to 0.5 [3], while the energy resolution for 5.5 MeV α and lateral inhomogeneity both are $< 2\%$.

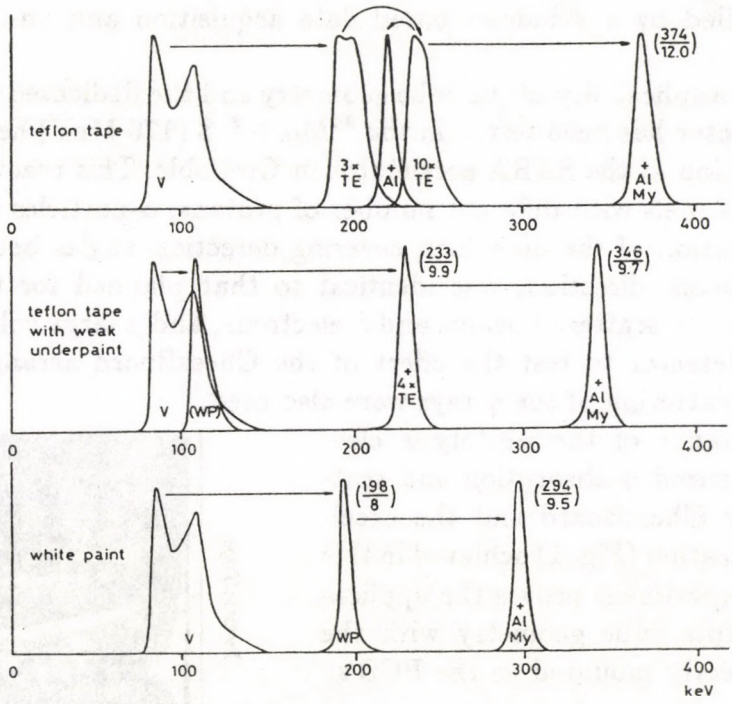


Fig. 1. Evolution of the spectral response of a small scintillator+ photodiode detector to 5.5 MeV α particles under various light collection conditions, displayed in the Si energy scale. V : virgin state, no reflectors at all; n×TE,WP,(WP) : n-layer teflon tape, thick and thin white paint on the sides, respectively; AlMy : aluminised Mylar on the front face; Al : directly evaporated front Al reflector; (E/ΔE) : mean energy / FWHM (keV_{Si}).

References

1. G. Kalinka et al., ATOMKI Ann. Rep. 1993, (1994) 140
2. J. Gál et al., ATOMKI Ann. Rep. 1993, (1994) 142
3. J.D. Valentine et al., IEEE Trans. Nucl. Sci. NS-40 (1993) 1267

Performance test of ChessBoard: a charged-particle detector system

B.M. Nyakó, J. Gál, G. Kalinka, G.E. Perez,

A. Kerek [a], A. Johnson [a] and J. Gizon [b]

[a]The Royal Inst. of Technology, Physics Dept-Frescati, Stockholm, Sweden
[b]Institut des Sciences Nucléaires, Grenoble, France

A test modul of the CUBE-geometry CsI detector system [1] proposed as one of the ancillary charged-particle detectors for the future EUROBALL γ-ray facility has been built. This ChessBoard-like system consists of 5x5 CsI(Tl)+PIN-photodiode detectors [2] mounted on a glass-fiber enforced Printed Circuit Board (PCB), the other side of which holds 25 preamplifiers [3] directly connected to the detectors via vacuum feedthroughs. The output of the preamplifiers, made of surface mounted components, are connected to a dual Particle Discriminator Unit (PDU) [4] which simultaneously supplies data for the type and the energy of the particles to a PC interface, controlled by a Windows based data acquisition and on-line monitoring software [5].

To check the applicability of the cube geometry and the dedicated electronics, the ChessBoard detector has been tested in the ^{94}Mo + ^{32}S (170 MeV) heavy-ion fusion-evaporation reaction at the SARA accelerator in Grenoble. This reaction has several open reaction channels with different number of protons, α-particles (and neutrons) emitted. The position of the detectors, covering detection angles between 45°–135° relative to the beam direction, was identical to that planned for the CUBE. Ta absorbers to stop the scattered beams and δ-electrons, and a large volume Compton-suppressed Ge detector to test the effect of the ChessBoard arrangement for the absorption and scattering of the γ-rays were also used.

The performance of the prototype electronics, the measured γ-absorption and scattering caused by ChessBoard and the excellent particle separation (Fig. 1) achieved in this first heavy-ion experiment proves the applicability of the simple cube geometry with the preamplifiers directly mounted on the PCB's.

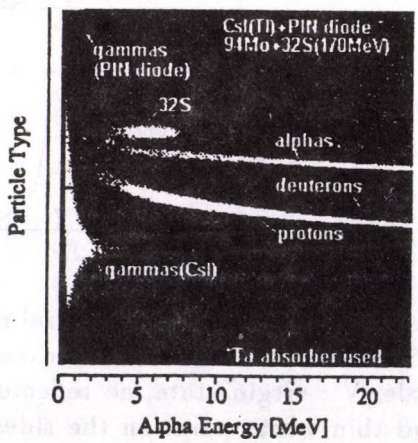


Figure 1. A Particle-type vs. Energy 2D-spectrum collected with a CsI detector at 55° using 4.4 μm Ta absorber.

[1] G. Kalinka et al., ATOMKI Annual Report 1993 (1994) p.140
[2] G. Kalinka et al., this Annual Report
[3] J. Gál et al., submitted to Nucl. Instrum. Meth.
[4] J. Gál et al., this Annual Report
[5] G.E. Perez and M. Emri, this Annual Report

Noise analysis of room temperature Si pin photodiode detector systems

G. Kalinka

There has been an ever increasing popularity of Si pin photodiodes as direct detectors of nuclear radiation either at room temperature or with moderate cooling, as well as coupling them to scintillator crystals.

In order to optimise performance detailed electronic noise analysis has been carried out in the time domain [1], developed earlier for cooled Si(Li) X-ray detectors [2], when the expression

$$NLW^2 = A < N_s^2 > + B < N_\Delta^2 > + C < N_{-1s}^2 >, \qquad (1)$$

is valid, NLW being the electronic noise line width, A, B, C are the parallel, series, and f^α type noise parameters, while the corresponding noise indices for the NZ-870 time variant signal processor used, with the possibility of continous adjustment of the peaking time T_p in the 5-50 μs range, are $< N_s^2 >= 0.67\,T_p$, $< N_\Delta^2 >= 2/T_p$, and $< N_{-1s}^2 >= 5.55$ [3]. The most important results for typical low and high capacitance diodes (Hamamatsu S1223 : 8 pf, S3590-03 : 50 pf) coupled to well matched JFETs (2N4416 and 2SK147) are summarised in Fig.1.

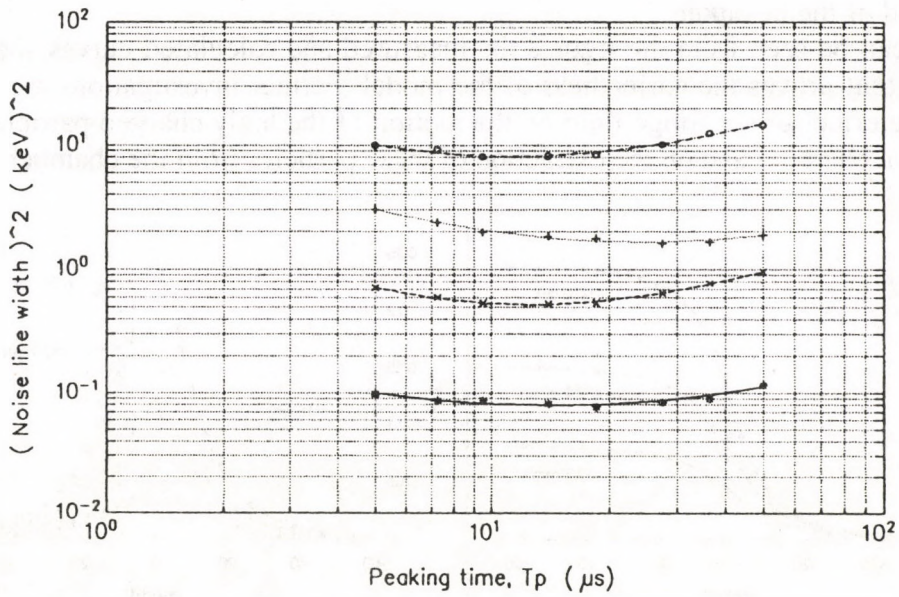


Fig. 1. Noise analysis results fitted with eq.(1).
$*, \times$: 2N4416 FET + 56 GΩ without and with S1223 diode,
$+, \circ$: 2SK147 FET + 5 GΩ without and with S3590-03 diode.
Noise minima correspond to 0.28, 0.73, 1.27 and 2.80 keV respectively.

References

1. G. Bertuccio and A. Pullia, Rev. Sci. Instrum. **64** (1993) 3294
2. G. Kalinka, Thesis, Debrecen 1980.
3. T. Lakatos, Thesis, Debrecen 1982.

3D magnetic field mapping of a NdFeB hexapole magnet ring

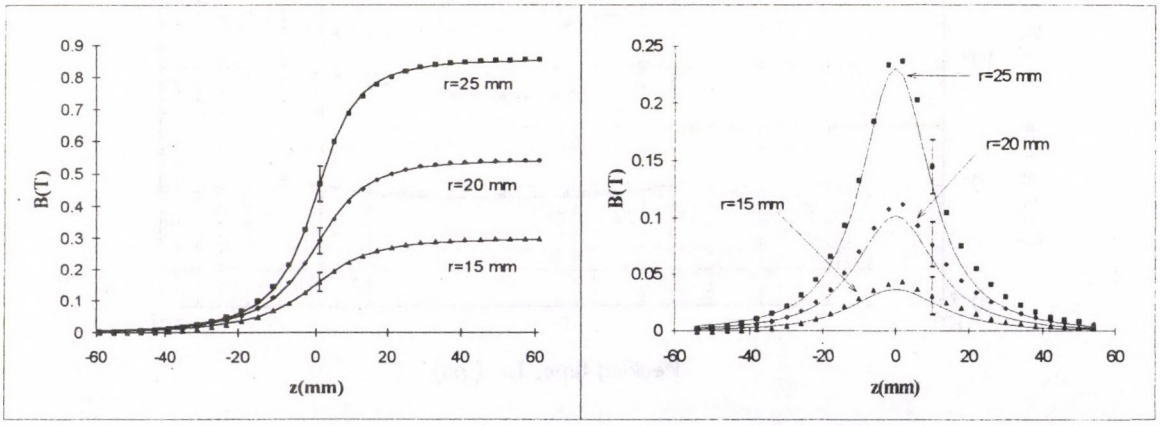
J. Vámosi, S. Biri, K.E. Stiebing* and H. Schmidt-Böcking*

*Institut für Kernphysik, *Johann Wolfgang Goethe Universität*
Frankfurt am Main, Germany

In the frame of a scientific-technological contract between the ATOMKI and the Institut für Kernphysik of the J.-W. Goethe University (Frankfurt/M, Germany) magnetic field masurements were performed on the 24-segment Halbach-type hexapole magnet of the 14.5 GHz Frankfurt ECR ion source.

The purpose of these measurements was to prove the correctness of previously determined and published semi-empirical formulas [1] that describe the components of the magnetic induction at the end of the magnet. The magnetic induction was measured [2] by Hall-probes. The figures below show the results of the measurements. In the left figure the radial (or azymuthal), while in the right figure the axial component of the magnetic induction can be seen at 3 different radii as the function of the axial position near the end of the hexapole.

As it can be seen from the figures the measured and calculated curves show good agreement that proves the correctness of the model. Further investigations are planned to study the effect of the fringe field on the motion of the higly charged particles in the ECR plasma chamber and on the extraction of these particles from the chamber.



References

[1] J.VÁMOSI AND S. BIRI, Nuclear Instruments and Methods B **94** (1994) 297.

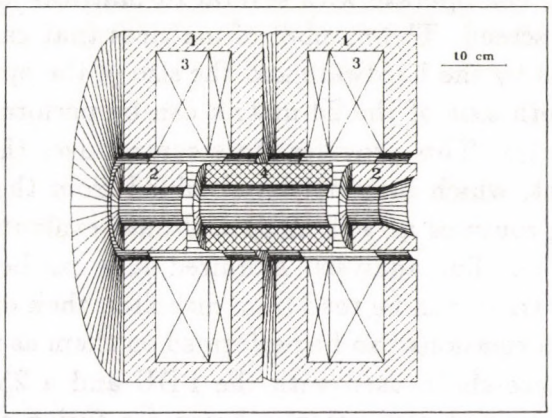
[2] S. BIRI, J. VÁMOSI, K.E. STIEBING AND H. SCHMIDT-BÖCKING, in Proc. of HCI '94 Conference, Vienna, 1994 (to be published in the NIM B).

Progress of the ECRIS Program

S. Biri, F. Gáll, I. Szűcs, A. Valek and J. Vámosi

1994 was the second year of the Electron Cyclotron Resonance Ion Source (ECRIS) program of the ATOMKI*. In spite of the limited manpower and financial resources the program had a remarkable progress.

The designing of the magnetic system has been finished (see the figure). The magnetic field of the NdFeB hexapole (marked as 4 in fig.) was found to be between 0.95 and 1.05 Tesla at a radius that correspond to the inner wall of the plasma chamber. The special coils (marked 3) and a three-channel high current power supply have arrived at our institute. The 1 iron yoke has been manufactured in the workshop of the institute. The stand of the source is also completed. It will hold more a 1000 kg. The four main parts of the source (two big coils together with theirs iron yokes, injection & extraction parts) will be horizontally movable on this stand. The input of the 14.5 GHz transmitter was designed and built. The transmitter was tested using a dummy load at output. Four turbomolecular pump units with pumping speeds 250..500 l/s have been purchased to pump the source and the beamline. All the insulations of the source are designed for 60 kV. However, for financial reasons 30 kV power supplies were bought, that is the total energy of the beam will be 30Q keV where Q is the charge state of the accelerated heavy ions. The key element of the beamline: a double focussing dipole (analysing) magnet with r=24 cm has been ordered. The old Cockroft-Walton generator was dismantled and the room originally used by this machine was completely fit up for the ECR ion source. The necessary more then 200 kW electrical power connection has been recently built in the laboratory.



In addition to the developments, the research of the ECR source itself was also continued. Some promising results were achieved by modelling the elementary processes inside the ECR plasma trap [1].

Most of the main components (except the cooling system) of the ECR source have been acquired. The manufacturing of the missing elements (e.g. plasma chamber, connections, extraction optics) will be continued in 1995. The assembly of the source begins soon.

Reference

1. S. Biri, J. Vámosi, Proc. of the EPAC94, London, 1994, vol. 2, pp. 1432-34.
Also see the references in: J. Vámosi et al. (this Annual Report).

* The ECRIS program is supported by the 'Human Resources' project of the World Bank (OTKA Nr.: A077), by the OTKA (F013961 and F15088) and by the FEFA (HU-3313 697/2-AA-1).

A Two-Dimensional Data Acquisition Windows-Based Program

G.E. Perez and M. Emri[a]

A Windows-based graphics program for acquiring, storing, and visualizing 2-dimensional spectra has been developed for the Particle Discrimination Unit (PDU) of [1] used together with an Incremental Memory (IM) PC board.

The memory of the IM PC board amounts to 128Kbytes and it can operate in several acquisition modes, e.g. (i) 256x256 2-byte, (ii) 256x256 1-byte, (iii) 128x128 2-byte , etc., matrices. A so-called "Z" mode allows simultaneous acquisition into 2 matrices of 256x256 1-byte channels each.

The program itself can operate with several 2d-matrices at the same time which are visualized on the screen. The number of matrices that can be handled simultaneously is only limited by the hardware and the size of the operating memory. Cuts and projections on both axis of the 2d-matrix can be performed at anytime, which are treated as 1d-spectra. This provides more control over the measured quantities during the experiment, which may not be obtained from the 2d distribution only. Also, gaussian fitting routines as well as special data evaluation routines are being implemented for quick on-line analysis. Acquired data can be saved onto hard disk. In off-line analysis matrices can be read from disk files, then displayed on screen and different simple transformations can be performed on them as mentioned above. The program has been successfully used with the PDU and a 25-element CsI detector board for charged-particle identification in heavy-ion fusion-evaporation nuclear reactions. The "Z" mode was used for data acquisition allowing full monitoring of particle-type vs. energy information from a selected pair of CsI detectors [2].

For the program to be efficiently used one needs a IBM PC Compatible 486 with at least 4Mb operating memory and Windows 3.1 installed on it. The program was written using the Borland C^{++} 3.1 Applications Framework and the ObjectWindows Library.

Acknowledgments

This project was partially supported by the Hungarian Scientific Research Fund (OTKA No.T7481) and the Swedish National Research Council.

References

[1] J. Gál et al, ATOMKI Annual Report 1993, (1994) 142
[2] B. M. Nyakó et al, ATOMKI Annual Report 1994, (1995)

[a] DOTE PET Centrum, Debrecen

Fast Particle Detector for Energetic Ions

A. Báder, L. Sarkadi, Gy. Hegyesi, L. Víkor and J. Pálinkás

We developed a fast ion detector (see fig.1). The detection of the particles entering through the tube (A) is based on secondary electron conversion by an Al surface (B). To detect the secondary electrons we applied two microchannel-plates (MCP) instead of channeltron which was used in previous works[1,2]. The focusing cylinder (C) and a ring electrode, which were designed by using the SIMION code, distribute the electrons uniformly on the surface of the MCP. In the computer simulation we assumed that the electron emittance has a distribution described by a cosine function of the emission angle. To avoid reflections in case of fast signals we prepared the conical anode (F, G) very precisely according to the relation[3]: $Z=60\ln[\mathrm{tg}(\alpha_1/2)/\mathrm{tg}(\alpha_2/2)]$, where $Z=50$ in Ohms, α_1 and α_2 are the semi-angles of the outer and inner cones, respectively. We tested the detector for 50-1500 keV protons. The measured efficiency of the detector was found to be 0.8 at 1 MHz counting rate.

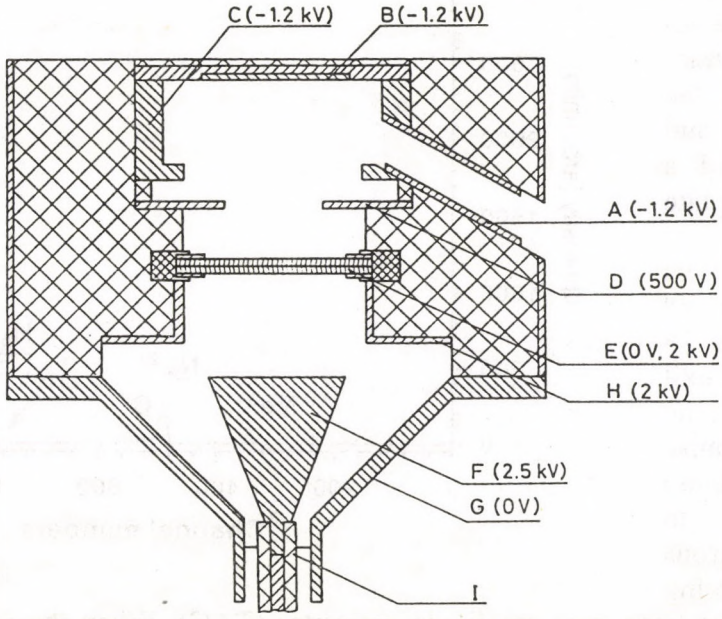


figure 1 - The scheme of the particle detector. A - entrance tube (-1.2 kV); B - converter plate (-1.2 kV); C - focusing cylinder (-1.2 kV); D - ring electrode (+500 V); E - cascade channel plates (front: 0 V, back: +2 kV); F - conical anode (+2.5 kV); G - outer cone (0 V); H - shielding ring (+2 kV); I - BNC connector

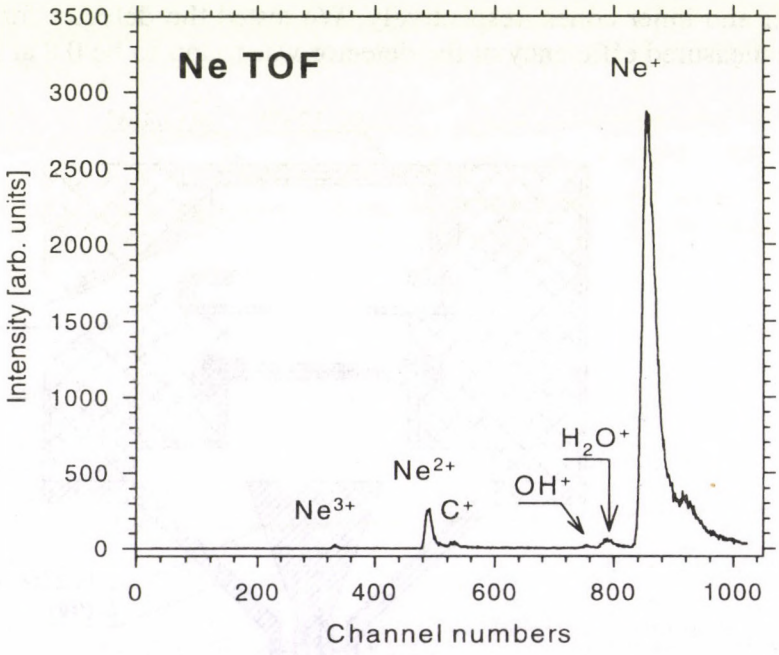
References

[1]K. Rinn, A. Müller, H. Eichenauer and E. Salzborn, Rev. Sci. Instrum. **53**, 829 (1982)
[2]D. A. Hayton and B. Peart, Meas. Sci. Technol. **5**, 247 (1994)
[3]G. Beck, Rev. Sci. Instrum. **52**, 1131 (1976)

A Recoil Ion Detector for the ESA-21 Electron Spectrometer

Gy.Víkor, L. Tóth, S. Ricz, Á. Kövér and J.Végh*

The ESA-21 electron spectrometer built at the beginning of the 80's [1] was mainly used to study the angular distribution of Auger and secondary electrons emitted from ion - atom collisions. For getting more information on the collision and the rearrangement process the analyzer was extended with a recoil ion detector to determine the charge state of the target atoms after the collision. One of the main advantages of the development is to separate the Auger lines of different origin. E.g. the Auger electrons in coincidence with recoil ions with 2+ charge state corresponds to diagram lines while the coincidence with 3+ charge state refers to satellite lines.



The parts of the recoil ion detector are the extraction electrode, the acceleration and drift lenses and a micro channel plate as detector.

When an electron is detected by one of the 13 detectors at the exit of the ESA-21, an electronic pulse (-200 V and 300 ns) is initiated to extract the electrons from the scattering region and to start the time amplitude converter (TAC). When the ions hit the micro channel plate the TAC is stopped and the measured time difference is directly related to ratio of the mass and charge of extracted ions. The acceleration and drift potentials are set to optimize the detector for the minimum time spread (time focusing).

The figure shows the time of flight spectrum of Ne ions from 4 keV $e^- \rightarrow$ Ne collision. For the Ne+, the FWHM is about 16 ns. The additional peaks originated from residual gases.

Reference:

*Permanent address: Institute of Physics, P.O.Box 57, 11001 Belgrade, Yugoslavia

[1] D.Varga, I.Kádár, S.Ricz, J.Végh, A.Kövér, B.Sulik and D.Berényi, *Nucl. Instr. and Meth.* **A313**, (1992) 163

Channeltron as a pulsed electron gun for coincidence measurements

Gy. Víkor, L. Tóth, S. Ricz, Á. Kövér, and J. Végh*

It is advantageous to use pulsed projectile electron beam for measuring the charge state distribution of target ions after electron - atom collision. The large number of remnant ions cause unwanted random coincidence events when they are measured in coincidence with secondary electrons. The general method is to chop the continuous electron beam, produced by a common electron gun with heated filament, by applying electronic pulses either on the deflection plates or on the Wehnelt electrode.

Recently we developed a new type of electron gun which produces pulsed beam. It is similar to that which was built by Spilberger *at al* [1]. The heated filament is replaced with a channeltron used normally for detecting electrons and a radioactive source (Am-241) . The other part of the electron gun is unchanged. The particles (α and photons) emerged from the radioactive source hit the entrance cone of the channeltron initiating secondary electrons which are multiplied by approximately 10^8 times inside the channeltron tube. At the exit the electron bunches are focused and their direction is corrected with the traditional lens elements.

The channeltron used for the gun is made by TESLA (Czechoslovakia) about 15 years ago. The size of the cone is 10 mm and the internal diameter of the tube is 1.5 mm. The applied high voltage is 3.5 kV. When a bunch leaves the channeltron a positive signal is generated at the exit electrode which can be used for triggering the coincidence circuits.

The gun was mounted into the ESA-21 electron spectrometer [2]. A collimator with apertures of diameter 1 and 0.5 mm was used to form the shape of the bunches and direct them to the interaction volume. The intensity of the pulsed beam is measured by a Faraday cup.

We determined the parameters of the bunches. The FWHM of the energy distribution is about 70-80 eV at 3.5 keV energy while the base energy width is about 150 eV. The main reason of this energy spread is that the last 10 mm of the tube is straight therefore the outgoing electrons originates from different potentials, The shape of the energy distribution depends on the extracting and focusing potentials. We estimate that the number of electrons in the bunches is about 10^5. The average current is 1 - 2 nA. The FWHM of the bunch length is less than 20 ns. The base width is 2.5 times wider. It was determined by measuring the time difference between the trigger pulse of the gun and the channeltron pulse at the end of the electron analyzer when the elastically scattered electrons were recorded.

The main advantages of this type of electron gun are the production of electron bunches with short length and the 'cold' cathode which can be set easily to high voltage. The disadvantage is the large energy spread of electrons. However, this energy spread is not so important when the cross section of the measured process does not depend strongly on the impact energy.

This pulsed electron gun is used together with a recoil ion detector [3] for measuring the ratio of the Ne^+ and Ne^{2+} remnant ions in coincidence with the secondary electrons [4].

References:

*Permanent address: Institute of Physics, P.O.Box 57, 11001 Belgrade, Yugoslavia

[1] L. Spielberger, O. Jagutzki, R. Dörner, J. Ullrich, H. Schmidt-Böcking, EAS-13, Ed. by J. Eicher, B. Fricke, Berlin (1992), 107

[2] D. Varga, I. Kádár, S.Ricz, J. Végh, Á. Kövér, B. Sulik and D. Berényi, *Nucl. Instum. Meth.* **A313** (1992) 163

[3] Gy. Víkor , L. Tóth, S. Ricz, Á. Kövér and J. Végh, recent Annual Report

[4] Gy. Víkor , L. Tóth, S. Ricz, Á. Kövér and J. Végh, recent Annual Report

Modifications in PIXYKLM Program Package

Gy. Szabó, I. Borbély-Kiss

The PIXYKLM program package has been made for total processing of X-ray spectra obtained by PIXE method on samples of arbitrary thickness. Concentrations are calculated by the absolute yield method, considering the secondary excitations, too. In case of spectra containing only K and L lines the projectile can be arbitrary with arbitrary energy, but in case of presence of M lines it can only be proton with energy 0.06-2.0 MeV because of the complicated M X-ray production cross section calculation. In detail see references [1, 2].

Recently the following modifications have been performed in the program package:

1. Certain parts of data base have been modified, the interpolation for the missing data are made more precisely.

2. In respect of concentration calculation any kind of X-ray line can be chosen as main line.

3. Certain parts of the code have been modified to get more reliable and simpler operation. With the help of the above code modification a later program development will be easier.

4. Direct reading of specrum files created by certain analyzer cards in special file format has been solved, e.g. the direct reading of the compressed spectrum file (method of compression is described in [3]) of the Oxford Microbeams system.

Detailed user friendly manual of the program package has been made.

References

1. Gy. Szabó, I. Borbély-Kiss: Nucl. Instr. Meth. in Phys. Res. B75 (1993) 123.
2. Gy. Szabó, I. Borbély-Kiss: ATOMKI Annual Report (1993) 96.
3. L. Zolnai, S. Szilágyi: Nucl. Instr. Meth. in Phys.Res. B14 (1986) 360.

The new scanning proton microprobe facility

I. Rajta, Gy. Mórik, L. Bartha, I. Borbély-Kiss,
E. Koltay and Á. Z. Kiss

Steps have been made for the building up of a proton microbeam facility at the 5 MV Van de Graaff accelerator in the years 1994-95. Independent financial sources have been provided by the National Foundation for Scientific Research (OTKA-A-080) and by the International Atomic Energy Agency (IAEA-CRP-7257/RB) for ordering the basic electron-optical units, data collecting electronics, computer software and optical zoom microscope from the Oxford Microbeams Ltd [1]. We have received these units by the end of 1993. Manufacturing of beam transport elements, vacuum system and target chamber have been done by Institute's staff. The SPM is equipped with a Si(Li) detector for PIXE measurements, a single channel electron multiplier for secondary electrons, and surface barrier Si detectors for backscattered, forward scattered and transmitted protons. The measured X-ray spectra are evaluated with the PIXYKLM program [2], which have been modified for microprobe applications.

Several tests have been made in order to measure the beam size. An example of the results of these tests can be seen on the figure below. This is a gold grid with a repeat distance of 12.5 microns. It can be seen clearly that the beam size must be less than 5 μm because the grid is visible.

Figure 1. PIXE map of an Au grid (d=12.5 μm)

There was also a line scan test across the edge of one bar of this gold grid and on a Si crystal. It showed that the beam diameter was 1 micron when the beam current was 30 pA. About 2 microns can be reached with 100 pA target current.

The fields of the possible applications are being surveyed recently.

References

1. G. W. Grime, M. Dawson, M. Marsh, I. C. McArthur and F. Watt, Nucl. Instr. and Meth., **B54** (1991) 52-63
2. Gy. Szabó and I. Borbély-Kiss, Nucl. Instr. and Meth., **B75** (1993) 123-126

Retarding Electron Lens System for a Cylindrical Mirror Analyzer

A. Hiltunen[a], K. Tőkési, S. Aksela[a] and D. Varga

[a] Department of Physics, University of Oulu, SF-90570 Oulu 57, Finland

Cylindrical mirror analyzers (CMA) have been widely used in atomic and surface physics due to their good focusing and dispersion properties. In order to achieve high absolute resolution independent of the initial electron energy, it is necessary to use a retarding electron lens system. The redardation lens system gives freedom to choose the appropriate compromise between intensity and resolution for any specific problem. Due to the cylindrical symmetry the redartation lens is getting complicated and the problem has not been solved yet for a CMA with an optimal way. An optimal redartation lens system is important for a good transmission which is an characteristic advantage of CMA.

Our study gives a possible solution for this problem. We has studied a double pass cylindrical mirror analyzer, in which a conical lens system with three elements has been located between the two stages. The lens system is placed inside the inner cylinders. The schematic view of this lens system with the calculated electron trajectories is shown in Fig 1. This kind of retarding lens system was built in Oulu and is used in the CMA of the physics department.

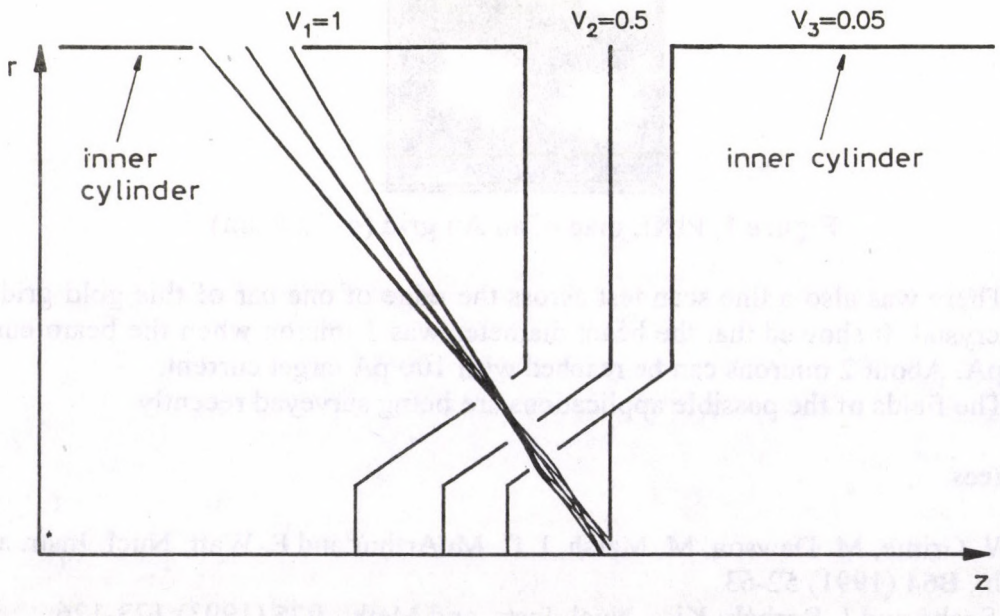


Figure 1. Schematic view of the conical lens system with the calculated electron trajectories

In a near future we will extend the calculation for a four element lens system.

The periodical property of the transmission in a prefilter quadrupole system

M. Simon , S. Bohátka , Cs. Trajber*, D. Varga

A computer simulation program has been constructed to model the motion of ions in the field of quadrupole mass analyzers [1]. It has been successfully used to calculate the resolution and transmission of the QMS as well as to optimize the length of the prefilter coupled to the analyzer [2]. The program can calculate the average maximum displacement of ions from the axis of the quadrupole rod system [3].The average maximum displacement function (D_r) well characterizes the transmission of quadrupole mass filter : the higher the displacement is the smaller the probability of free ion transmission through the analyzers will be . Calculation revealed that D_r and consequently the transmission of a QMS with prefilter is a periodic function of the length of the prefilter[2]. This behavior was experimentally proved for He ions earlier [4] and experiments have been extended to higher masses in these measurement.

For higher molecular weight ions the experimental procedure is more complicated. . A mass selective ion source had to be constructed to produce ions of controlled masses at the entrance of the prefilter - mass filter assembly (Figure 1).

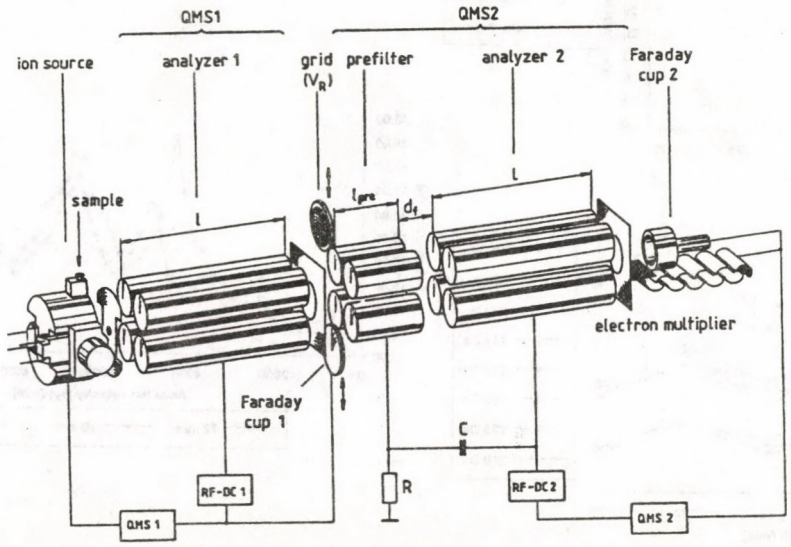


Fig.1. Schematic arrangement of the experimental setup of the measurement of ion transmission. The ion source and analyzer1 produce selected ions for the prefilter - analyzer2 assembly.

Fragment ions of hexachlor-butadiene were produced in a closed ion source and the first analyzer (QMS1) was set to a certain mass number. Eight masses in the range of 12 to 260 Da were measured (Figure 2b.)

Transmission of the prefiltered quadrupole (QMS2) was determined as the ratio of outcoming ions detected on Faraday cup 2 and the incoming ions on Faraday cup 1.The latter one was a rotatable metal plate. Incoming ions were measured first and in 1 minute the measurement of outcoming ions was also completed at the same ion source pressure. The energy of incoming ions was determined by applying retarding potential (V_R) on the metal grid in front of Faraday 1. Ion source potentials were calibrated against ion energy and measurements were carried out at a fixed

* GE - TUNGSRAM Budapest

energy (velocity) of ions. During measurements the grid was retracted. Reproducibility of the transmission measurements was within 8%.

Experimental values show periodicity in transmission as a function of prefilter length. Both calculated D_r function and calculated transmission values at certain prefilter lengths as well as measured values at 141 Da are shown in Figure 2a. Experiments verify expectations: maxima of transmission coincide with D_r minima. The periodicity is the same at higher masses, too when the velocity of ions is the same for all masses .

There is an additional experimental proof concerning the periodical property of the transmission in case of prefilter-QMS system. The average maximum displacement (D_r) is a combination of sine and cosine functions of l_{pre}/v_z [2]. It is not surprising that, at a fixed prefilter length, the transmission is a periodic function of ion velocity (v_z) (Figure 3).

Fringing field effects at the entrance of the mass analyzer have been experimentally studied. When ion velocity is low and the distance (d_f) is long between the two sets of rods the fringing field effects can be considerable, therefore it was experimentally determined. It is shown that the effect exists but it is negligible at $d_f = 0.5$ mm (the distance, which was used in all our experiments).

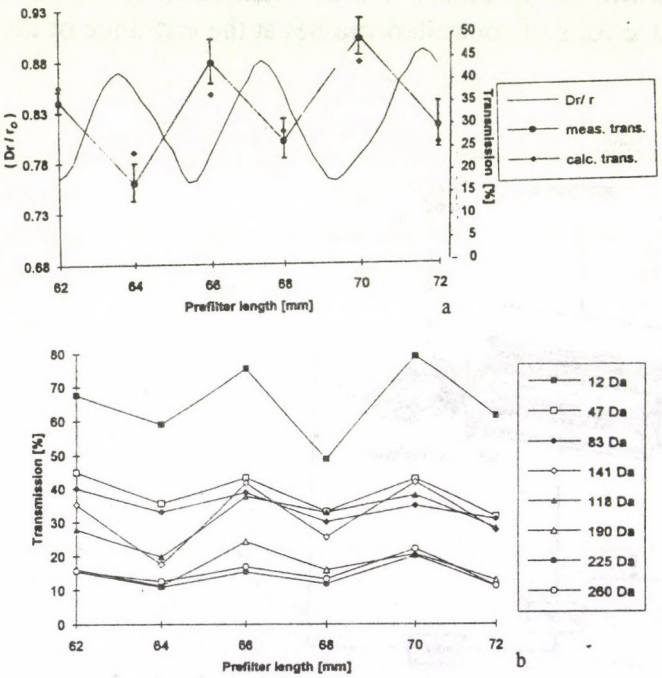


Fig 2a. Ion Transmission of pf-QMS at 141 Da masses as a function of prefilter length.
Fig. 2b. Ion transmission measured at different masses.

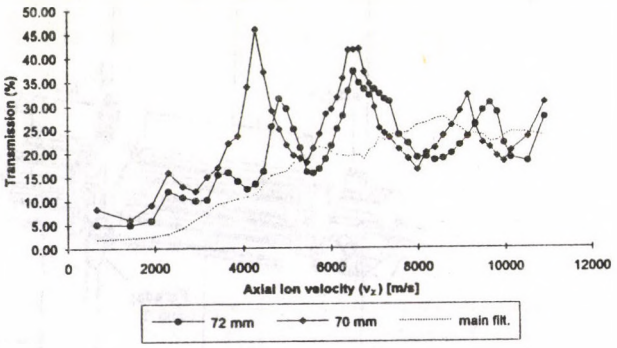


Fig. 3. Ion transmission measured at mass 141 Da Values obtained without prefilter and with two different lengths of prefilter are shown versus axial ion velocity.

CONCLUSION

The periodic nature of the transmission of quadrupole MS with prefilter as a function of prefilter length has been experimentally proved, without the influence of fringing fields at the entrance to the analyzer, in the mass range of 12 - 260 Da.

References:

1. Cs. Trajber, M. Simon and M. Csatlós, Meas. Sci. Technol., **2**, 785 (1991).
2 Cs. Trajber, M. Simon and S. Bohátka, Rapid Commun. Mass Spectrom., **6**, 459 (1992).
3. M. Simon , Cs. Trajber, S. Bohátka, and I Futó ATOMKI Annual Report (1992). 135
4. Cs. Trajber, M. Simon, S. Bohátka and I. Futó, Vacuum, **44**, 653 (1993).

Applications of artificial neural network chips

J. Molnár, G. Székely and Th. Lindblad*
*Royal Institute of Technology Department of Physics - Frescati, Stockholm

The future of the European Laboratory of Particle Physics (CERN) will be the Large Hadron Collider (LHC) which will be started to work in 2000. Our development fits into the NEBULAS R&D project [1] going on at many institutes all over the world.

In collaboration with Royal Institute of Technology Stockholm a so called Asynchronous Transfer Mode (ATM) test setup was developed. The main goal of the task was the experimental verification of the harware design principles and methods, partly the application of the test setup for testing the neural network controlled self-routing, asynchronous event-building ATM networks.

The general idea of using a neural network approach in ATM network control is the following: (i) The neural networks can learn the relation between the charasteristics, quality and results, and can adapt. (ii) Routing control with learning automata using conventional algorithms is very difficult is several parameters have to be considered. Neural networks can approximate complicated input/output relations and the feature parameters may be derived from the trained network.

In fig. 1 we can see the block diagram of a neural network controled ATM switching fabric with the router realising a general architecture of the data acquisition system.

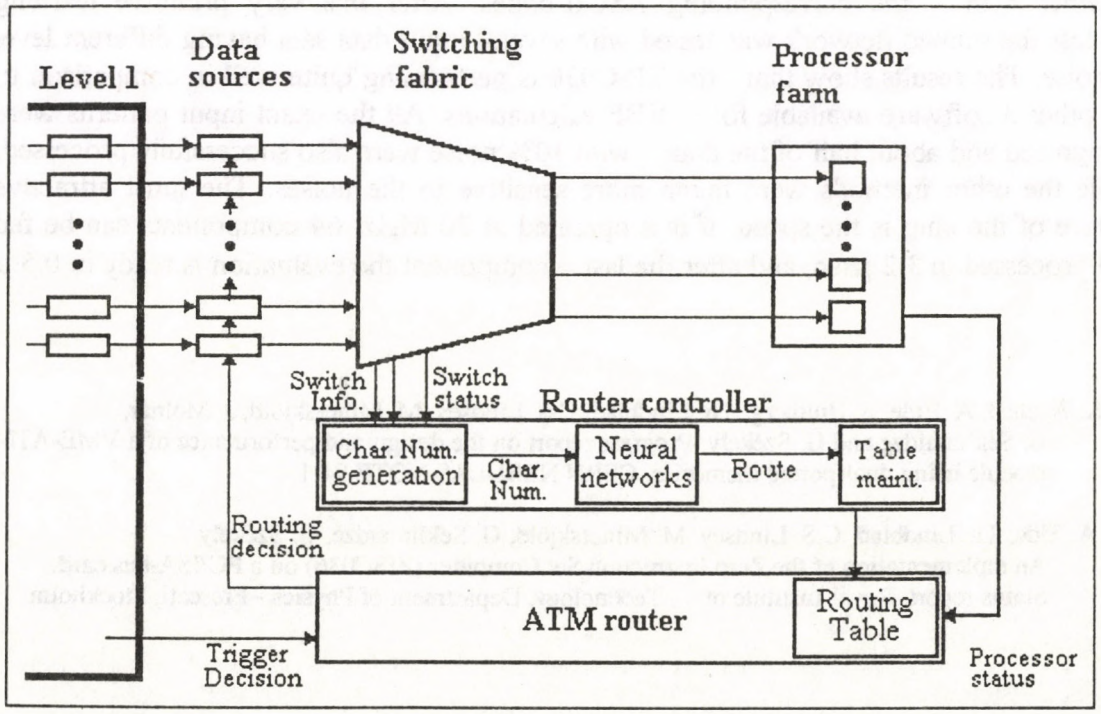


Fig. 1. General layout of the routing fabric.

We took part in the first implementation of the IBM Zero Instruction Set Computer (ZISC036) [2] on a PC-486 ISA-bus card. This chip has been designed for cost-effective recognition and classification in real time . It is achieved by a high degree of parallelism and a built-in Radial Basis Function (RBF) -type neural network topology. Only 36 neurons are contained in a chip, but it is easily cascadable due to the arrangement of its various buses, and the total number of neurons in the network is not limited. Due to this fact, the designers intend to use is not onlyas a neural network chip, but also as a very fast parallel processor for such tasks like searching strings in huge data bases.

During the learning process the consecutive training vectors are compared to the prototypes stored in the neurons of the hidden layer, and if the input point is within the influence field of such a neuron, then it falls to the same category as the neuron, otherwise a new neuron is created. The influence fields are adjusted when several neurons fire, e.g. have the input point within their influence fields.

The evaluation process gives the "K-nearest neighbours" for the input pattern, namely a list of categories belonging to the prototypes lying in the closest distance (in ascending order). If K=1, then the pattern was identified. If K>1, then the user can take the first category (whose prototype is the closest one) as the result, or can say that the pattern was recognized but not formally identified. The K=0 case says that the network can not categorize the input pattern.

After building the PC interface card and testing the main functions of the built-in logic a code for character recognition was developed for comparing its performance to other RBF-type methods. The map of the 26 capital letters (8x8 bits each) were supplied together with the corresponding ASCII-codes. After this very primitive learning process the trained network was tested with several input data sets having different level of noise. The results show that the ZISC036 is performing quite well in comparison to the other 3 software available for RBF calculations. All the exact input patterns were recognized and about half of the data with 10% noise were also successfully processed, while the other methods were much more sensitive to the noises. The most attractive feature of the chip is the speed: if it is operated at 20 MHz, 64 components can be fed and processed in 3.2 μsec, and after the last component the evaluation is ready in 0.5 μ sec.

[1] K. Agehed, A. Eide, S. Hultberg, Th. Lindblad, C.S. Lindsey, M. Minerskjöld, J. Molnár, G. Sekhniaidze and G. Székely: Progress report on the design and performance of a VME-ATM module using dual-ported memories. CERN NEBULAS NOTE 94-1

[2] A. Eide, Th. Lindblad, C.S. Lindsey, M. Minerskjöld, G. Sekhniaidze, G. Székely: An mplementation of the Zero Instruction Set Computer (ZISC036) on a PC/ISA-bus card. Status report, Royal Institute of Technology, Department of Physics - Frescati, Stockholm.

The Ethernet network of the institute

G. Székely, Zs. Dombrádi, A. Sipos

The project for building the institute's Ethernet network and connect it to the FDDI ring of the Debrecen Universitas has been completed at the end of 1994. Here we shortly describe our local area Ethernet network (LAN) in order to give a general view of its structure and operation.

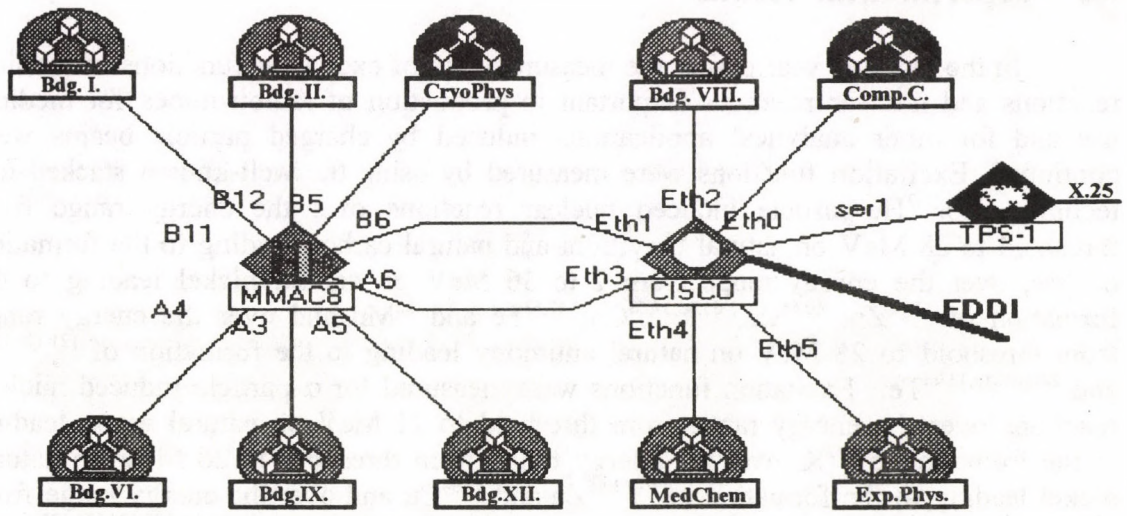


Fig. 1 The main map of the LAN as seen on the network manager PC.

From the right hand side of the picture the lines to the outside world (X.25 and the FDDI connection to the Universitas) can be seen. It means that we have two possibilities to connect to the world: a low speed (9.6 KBit/sec) public packet-switched line and a high speed (100 MBit/sec) cable to a ring of the universities and research institutes of Debrecen. This ring is connected to the Hungarian Internet Backbone (HBONE) via a router. The Debrecen-Budapest section of the HBONE is a leased line with a speed of 64 Kbit/sec.

Our main network device, the CISCO AGS+ router has a 6-port Ethernet card. Four of the six ports are directly connected through multi-mode optical cables to 6-port repeaters (represented by filled ellipse figures) enabling to connect max. 6 coaxial wire segments. The remaining two ports first go to an optical repeater (placed in MMAC8 in fig.1) each, which connect the repeaters of three individual buildings each.

The following table shows the Internet subnet numbers, their places and the computers connected on the network segment. The names of the machines can be found in the Domain Name Server moon.atomki.hu, having the Internet address 193.6.176.20.

193.6.176.0	Computing Centre:	2 Unix servers, 1 Network Manager PC, 1 Gateway PC, 1 Fileserver PC, 1 PC
193.6.177.0	Building I, II, CryoPhys:	3 workstations, 21 PC
193.6.178.0	Building VIII:	7 workstations, 16 PC
193.6.179.0	Building VI, IX, XII:	6 workstations, 27 PC
193.6.180.0	DOTE Med. Chemistry:	1 PC
193.6.181.0	KLTE Exp.Physics Dept:	2 workstations, 11 PC

The two central Unix machines are used as a computing server (SGI Power Challenge) and as a communication and library server (Sun SPARCserver 10/52). Alltogether 18 workstations and 80 PCs are connected on the LAN not counting those machines which are not registered in the Domain Name Server. The protocols supported by the CISCO router are Internet, Decnet and IPX (only local). Our Decnet area number is 36.

Status Report on Nuclear Data for Application

F. Tárkányi, S. Takács, F. Szelecsényi, L. Andó, F. Ditrói and A. Fenyvesi

New experimental results

In the last one year period the measurements of excitation functions of monitor reactions and nuclear reactions important in production of radioisotopes for medical use and for other analytical applications induced by charged particle beams were continued. Excitation functions were measured by using the well-known stacked-foil technique for ^{3}He-particle induced nuclear reactions over the energy range from threshold to 28 MeV on natural beryllium and natural carbon leading to the formation of ^{7}Be, over the energy range from 2 to 36 MeV on natural nickel leading to the formation of ^{62,65}Zn, ^{60,61}Cu, ^{55,56,57,58}Co, ^{52,53}Fe and ^{52}Mn and over the energy range from threshold to 28 MeV on natural antimony leading to the formation of ^{121,123,124}I and ^{121m,121g,123m}Te. Excitation functions were measured for α-particle induced nuclear reactions over the energy range from threshold to 21 MeV on natural argon leading to the formation of ^{43}K, over the energy range from threshold to 26 MeV on natural nickel leading to the formation of ^{62,63,65}Zn and ^{61,64}Cu and over the energy range from threshold to 21 MeV on natural antimony leading to the formation of ^{123,124,125,126}I and ^{123m}Te. Excitation function of ^{nat}Ne(p,x)^{22}Na nuclear reaction was measured from threshold to 18.0 MeV bombarding proton energy. The experiments were performed in collaboration with the Accelerator Laboratory of Åbo Akademi, Turku, Finland and the Institute für Nuklearchemie, Forschungszentrum Jülich GmbH, Jülich, Germany.

Development of methods and instruments

Development of a computer (PC AT 386) controlled high resolution gamma-spectrometer-sample changer equipped with a Canberra HpGe detector, a Nucleus PCA-II 8000 MCA plug-in analyzer card and sample changer (driven by three step motors) has been completed. The control software provides an easy operated and programmed measurements of up to 32 irradiated samples stored in lead shielded sample holder.

Data compilation in EXFOR format

Evaluation of experimental cross section data of charged particle induced nuclear reactions in EXFOR format has been continued in collaboration with the IAEA Nuclear Data Section. Altogether 36 new entries were compiled in 1994.

Compilation and critical evaluation of cross section and thick target yield data of nuclear reactions used for production of ^{11}C isotope for PET investigations, ^{123,124}I and ^{201}Tl medically important isotopes were started.

This work was partly supported by the International Atomic Energy Agency project No. 6969/R1/RB and by the National Committee for Technical Development project No. 02690-91-11-08

Activities at the Van de Graaff Accelerator Laboratory

L. Bartha, Á.Z. Kiss, E. Koltay, Gy. Mórik,

E. Somorjai and Gy. Szabó

During 1994 the beam time of the VdG–1 machine amounted to 877 hours. The accelerator delivered proton and carbon beams for atomic physics during 821 hours, and it produced carbon beam in 56 hours for high energy implantation in surface science. A new target chamber for nuclear astrophysics on the VdG–1 machine has been completed this year.

The 5 MeV Van de Graaff machine was operated for 1800 hours during this period. Mainly protons (89 %) and $^4He^+$ ions (9 %) were accelerated, the supply of other ions $^2H^+$ $^{12}C^+$ and $^{14}N^+$ amounted to 25 hours.

The sandblasted accelerating tube has been working properly since it has been set to operation (2614 running hours).

Deuterons were accelerated and used for DIGME analysis [1] for the first time in the history of this machine. The neutron radiation remained at a safe level near the target chamber. Turning back to protons after a day's run a decreasing neutron yield was observed for a few hours near to the beam defining slits before and after the analyzing magnet. The final conclusion of the deuteron experiment was that no radiation hazard is expected in the case of nA deuteron beams with energies less than 3 MeV typically used for ion beam analysis in this laboratory.

The beam time was distributed among different research subjects and used for test runs as it is shown in table 1. About the installation and test of a scanning proton microprobe on the 0° beamline see a separate report in this volume.

Field	Hours	%
Atomic physics:	840	47
Nuclear physics:	485	27
Analytical studies:	209	12
Materials sience:	134	7
Test of the microprobe:	109	6
Machine tests:	25	1
Total:	1800	100

Table 1. Time distribution among different research activities at VdG–5

Reference

1. Á. Z. Kiss, I. Biron, T. Calligaro, J. Salomon, Nucl. Instr. Meth. **B85** (1994) 118.

Status Report on the Cyclotron

A. Valek

The planned operation of the cyclotron was similar to that of the previous years. The utilisation of the machine was concentrated to 9 months; January, July and August were reserved for maintenance and holiday.

The overall working time of the cyclotron was 4247 hours and the break down periods amounted only 59 hours. The cyclotron was available for users during 3467 hours, the effectively used beam time is summarised in Table 1. (FERMI: Front-End Readout MIcrosystem, Radiation hardness measurements, CERN RD-16).

In January the sophisticated digital control unit of the magnet power supplies was replaced with a more simple and reliable analogous one, remaining the possibility of a computer control in the future.

Table 1. Effectively used beam time

Projects	Beam time (hours)	%
Nuclear spectroscopy	388	14
Neutron physics	99	4
Particle spectroscopy	718	26
Nuclear astrophysics	140	5
FERMI	144	5
Detector development	86	3
Applications	1193	43
Total	2768	100

PUBLICATIONS

AND

SEMINARS

Papers published in 1994

Nuclear Physics

1. Tárkányi F., Szelecsényi F., Kopecky, P., Molnár T., Andó L., Mikecz P., Tóth Gy., Rydl, A., Cross section of proton induced nuclear reactions on enriched ^{111}Cd and ^{112}Cd for the production of ^{111}In for use in nuclear medicine, Applied Radiation and Isotopes **45** (1994) 239
2. Lind, P., Liotta, R. J., Maglione, E., Vertse T., Resonant state expansions of the continuum, Zeitschrift für Physik **A** 347 (1994) 231
3. Bacelar, J., Buda, A., Balanda, A, Krasznahorkay A., Van der Ploeg, H., Sujkowski, Z., Van der Woude, A., Di-lepton yield from the decay of excited ^{28}Si states, Nuclear Physics **A** 569 (1994) 101
4. Szelecsényi F., Boothe, T.E., Tavano, E., Plitnikas, M., Tárkányi F., Compilation of cross sections/thick targets yields for ^{66}Ga, ^{67}Ga and ^{68}Ga production using Zn target up to 30MeV proton energy, Applied Radiation and Isotopes **45** (1994) 473
5. Krasznahorkay A., Balanda, A, Bordewijk, J.A., Brandenburg, S., Harakeh, M.N., Kalantar-Nayestanaki, N., Nyakó B.M., Timár J., Van der Woude, A., Excitation of the isovector GDR by inelastic alpha-scattering as a measure of the neutron skin of nuclei Nuclear Physics **A** 567 (1994) 521
6. Varga K., Suzuki, Y., Lovas R.G., Microscopic multicluster desctiption of neutron-halo nuclei with a stochastic variational method, Nuclear Physics **A** 571 (1994) 447
7. Takács S., Vasváry L., Tárkányi F., Remeasurement and compilation of excitation functions of proton induced reactions on iron for activation techniques, Nuclear Instruments and Methods in Physics Research **B** 89 (1994) 88
8. Cseh J., Lévai G, Semimicroscopic algebraic cluster model of light nuclei. I. Two-cluster-systems with spin-isospin-free interactions, Annals of Physics (N.Y.) 230 (1994) 165
9. Timár J., Quang, T.X., Fényes T., Dombrádi Zs., Krasznahorkay A., Kumpulainen, J, Julin, R, Brandt, S., Paar, V., Simicic, Lj., Structure of ^{66}Ga from (p,nγ) reaction, Nuclear Physics **A** 573 (1994) 61
10. Morton, C.R., Dasgupta, S., Hinde, D.J., Leigh, J.R., Lemmon, R.C., Lestone, J.P., Mein, J.C., Newton, J.O., Timmers, H., Rowley, N., Kruppa A.T., Clear signatures of specific inelastic and transfer channels in the distribution of fusion barriers, Physical Review Letters **72** (1994) 4074
11. Lévai G., Solvable potentials associated with SU(1,1) algebras: a systematic study, Journal of Physics **A** 27 (1994) 3809
12. Beaumel, D., Fortier, S., Galés, S., Guillot, J., Langevin-Joliot, H., Laurent, H., Maison, J.M., Vernotte, J., Bordewijk, J.A., Brandenburg, S., Krasznahorkay A., et al., Decay modes of high-lying single-particle states in ^{209}Pb, Physical Review **C** Nuclear Physics 49 (1994) 2444
13. Csótó A., Three-body resonances in ^{6}He, ^{6}Li, and ^{6}Be, and the soft dipole mode problem of neutron halo nuclei, Physical Review **C** Nuclear Physics 49 (1994) 3035
14. Gácsi Z., Raman, S., Decays of ^{116}Sb isomers to levels in ^{116}Sn, Physical Review **C** Nuclear Physics 49 (1994) 2792

15. Bredbacka, A, Brenner, M., Kallman, K.-M., Manngard, P., Máté Z., Szilágyi S., Zolnai L., Low-energy elastic-scattering of alpha particles from ^{34}S, ^{50}Cr and ^{62}Ni, Nuclear Physics **A** 574 (1994) 397
16. Bordewijk, J.A., Balanda, A, Beaumel, D., Blomgren, J., Brandenburg, S., Van't Hof, G., Harakeh, M.N., Hofstee, M.A., Janecke, J., Krasznahorkay A., et al., Neutron decay of the isobaric analog state in ^{208}Bi, Nuclear Physics **A** 574 (1994) 453
17. Balanda, A, Bacelar, J., Betak, E., Bordewijk, J.A., Krasznahorkay A., Van der Ploeg, H., Siemssen, R., Wilshut, H., Van der Woude, A., Photons in the proton-induced reaction with In at Ep=50 MeV, Nuclear Physics **A** 575 (1994) 348
18. Csótó A., Baye, D., Microscopic description of the beta delayed deuteron emission from ^{6}He, Physical Review **C** Nuclear Physics 49 (1994) 818
19. Csótó A., Three-body resonances by complex scaling, Physical Review **C** Nuclear Physics 49 (1994) 2244
20. Varga K., Suzuki, Y., Ohbayasi, Y., Microscopic multicluster description of the neutron-rich helium isotopes, Physical Review **C** Nuclear Physics 50 (1994) 189
21. Söderman, P.-O., Blomgren, J., Ringbom, A., Krasznahorkay A., et al., Neutron decay of deep-hole states populated by the ^{208}Pb(^{3}He,α)^{207}Pb reaction 102 MeV, Nuclear Physics **A** 576 (1994) 215
22. Fahlander, C., Seweryniak, D., Nyberg, J., Dombrádi Zs., Perez Lopez, G.E., Józsa M., Nyakó B.M., et al., In-beam spectroscopy of ^{110}Te, Nuclear Physics **A** 577 (1994) 773
23. Varga K., Lovas R.G., Suzuki, Y., Microscopic multicluster description of neutron halos, Zeitschrift für Physik **A** 349 (1994) 347
24. Varga K., Lovas R.G., Liotta, R. J., Absolute alpha-decay width of ^{212}Po in a mixed shell-and-cluster model, Zeitschrift für Physik **A** 349 (1994) 345
25. Cseh J., The semimicroscopic algebraic cluster model of atomic nuclei, Zeitschrift für Physik **A** 349 (1994) 351
26. Raisanen, J., Rauhala, E., Fülöp Zs., Kiss Á.Z., Somorjai E., Hunyadi I., Stopping powers of CR-39 nuclear track material for Z=1-14 ions with 0.25-2.8 MeV/u, Radiation Measurements **23** (1994) 749
27. Petrache, C.M., Kiss Á.Z., et al., Detailed level scheme of ^{151}Tb and the feeding of the normal-deformed states by the superdeformed bands, Nuclear Physics **A** 579 (1994) 285
28. Cooper, S.G., Mackintosh, R.S., Csótó A., Lovas R.G., Local ^{4}He-p potentials from resonating-group method phase shifts, Physical Review **C** Nuclear Physics 50 (1994) 1308
29. Dombrádi Zs., Nyakó B.M., Perez Lopez, G.E., Algora, A., Fahlander, C., et al., Identification and spectroscopy of the ^{108}Te nucleus, Zeitschrift für Physik **A** 350 (1994) 3
30. Gácsi Z., Dombrádi Zs., Level scheme of ^{114}Sb from the (p,nγ) reaction, Physical Review **C** Nuclear Physics 50 (1994) 1833
31. Cseh J., Multichannel dynamical symmetry and heavy ion resonances, Physical Review **C** Nuclear Physics 50 (1994) 2240
32. Török I., Transzmutáció: új varázsszó az atomerőművi radioaktiv hulladék kezelésében? Fizikai Szemle **44** (1994) 48

Atomic Physics

1. Bakos J., Fúziós plazmafizika Az atomenergia- és magkutatás újabb eredményei. Szerk. Koltay E. Bp., Akadémiai K. (1993) 195
2. Biri S., Gyorsítóberendezések nehézionforrásai, Az atomenergia- és magkutatás újabb eredményei. Szerk. Koltay E. Bp., Akadémiai K. 10 (1993) 137
3. Berényi D., 5^{th} Workshop on Fast Ion-Atom Collisions. Debrecen, July 17-19,1993. Comments on Atomic and Molecular Physics **29** (1994) 333
4. Ricz S., Angular dependence of post-collision interactions, Nuclear Instruments and Methods in Physics Research **B** 86 (1994) 119
5. Tőkési K., Wang, J., Olson, R.E., Projectile ionization at forward observation angles for intermediate energy H+H collisions, Nuclear Instruments and Methods in Physics Research **B** 86 (1994) 147
6. Tóth L., Víkor Gy., Ricz S., Pelicon, P., Miller, R., Study of the Ar LMM spectra by He^+ projectile at 1250 keV, 1500 keV and 2000 keV bombardment energies, Nuclear Instruments and Methods in Physics Research **B** 86 (1994) 151
7. Mukoyama, T., Hock G., Analytical expressions of potentials and wave functions for atoms and ions, Nuclear Instruments and Methods in Physics Research **B** 86 (1994) 155
8. Nagy L., Végh L., Two-electron processes in ionisation of molecular hydrogen, Nuclear Instruments and Methods in Physics Research **B** 86 (1994) 165
9. Závodszky, P.A., Gulyás L., Sarkadi L., Vajnai T, Szabó Gy., Ricz S., Pálinkás J., Berényi D., Cusp shape studies in $H^+ \rightarrow$He collision in the energy range of 75-1400 keV: experiment and theory, Nuclear Instruments and Methods in Physics Research **B** 86 (1994) 175
10. Plano, V., Haar, R.R., Tanis, J.A., Pálinkás J., Sarkadi L., Závodszky, P.A., Berényi D., Khemliche, H., Prior, M.H., Schneider, D., Production of low-energy continuum electrons at 0^o by 4.4 keV/u O^{8+} ions, Nuclear Instruments and Methods in Physics Research **B** 86 (1994) 181
11. Tőkési K., Hock G., Versatility of the exit channels in the three-body CTMC method, Nuclear Instruments and Methods in Physics Research **B** 86 (1994) 201
12. Papp T., Campbell, J.L., Raman, S., Line-shape effects on the determination of Coster-Kronig probabilites using Si(Li) x-ray detectors, Physical Review **A** 49 (1994) 729
13. Papp T., Campbell, J.L., Raman, S., Angular correlation of K-L x-ray cascades in gadolinium, Physical Review **A** 49 (1994) 770
14. Sarkadi L., Berényi D., Proceedings of the 16^{th} International Conference on X-Ray and Inner-Shell Pocesses (X'93). Debrecen, Hungary. July 12-16,1993. Eds.: László Sarkadi, Dénes Berényi Nuclear Instruments and Methods in Physics Research **B** 87 (1994) 307
15. Hock G., Berényi D., Proceedings of the Fifth Workshop on Fast Ion-Atom Collisions. Debrecen, Hungary, 17-19 July 1993. Eds: G.Hock, D.Berényi Nuclear Instruments and Methods in Physics Research **B** 86 (1994) 1
16. Dörner, R., Mergel, V., Ali, R., Buck, U., Cocke, C.L., Tőkési K., et al., Electron-electron interaction in projectile ionization investigated by high resolution recoil ion momentum spectroscopy, Physical Review Letters **72** (1994) 3166
17. Kövér Á., Laricchia, G., Charlton, M., Doubly differential cross sections for collisions of 100 eV positrons and electrons with argon atoms, Journal of Physics **B** 27 (1994) 2409

18. Fainstiein, P.D., Gulyás L., Salin, A., Angular distribution of electrons ejected from argon by 350 keV proton impact: CDW-EIS approximation, Journal of Physics **B** 27 (1994) 259
19. Takács E., Ricz S., Végh J., Kádár I., Pálinkás J., Sulik B., Tóth L., Berényi D., Kabachnik, N.M., Alignment of the 1s2p vacancy states of Ne doubly ionized by 700-2000-keV proton impact, Physical Review **A** 50 (1994) 1197
20. Závodszky, P.A., Sarkadi L., Víkor L., Pálinkás J., Observation of collisionally induced (1s2p2p')4Pe shape resonance of He^-, Physical Review **A** 50 (1994) 899
21. Berényi D., Sarkadi L., Kövér Á., Pálinkás J., Comments on the shape of the "cusp" in the spectrum of electrons emitted in H^+, $H^0 \rightarrow$ Ar collisions, Acta Physica Hungarica **74** (1994) 405
22. Végh L., Macek, J.H., Coherences in the decay of autoionizing states in photoionization. I. Exchange effect between photo- and Auger electrons, Physical Review **A** 50 (1994) 4031
23. Nagy L., Végh L., Electronic correlation in the ionization of molecular hydrogen, Physical Review **A** 50 (1994) 3984
24. Végh L., Coherences in the decay of autoionizing states in photoionization. II. Coherences of nondegenerate states, Physical Review **A** 50 (1994) 4036
25. Moxom, J., Laricchia, G., Charlton, M., Kövér Á., Meyerhof, W.E., Threshold effects in positron scattering on noble gases, Physical Review **A** 50 (1994) 3129
26. Laricchia, G., Moxom, J., Charlton, M., Kövér Á., Meyerhof, W.E., Near threshold effects in positron-atom (molecule) scattering, Hyperfine Interactions **89** (1994) 209
27. Kövér Á., Laricchia, G., Charlton, M., Differential ionization studies at forward angles, Hyperfine Interactions **89** (1994) 129
28. Gulyás L., Szabó Gy., Resonant double electron capture by fast He^{2+} from helium: the first-order Born approximation with correct boundary condition, Zeitschrift für Physik **D** 29 (1994) 115
29. Kabachnik, N.M., Tulkki, J., Aksela, H., Ricz S., Coherence and correlation in the anisotropy of Ne KL-LLL satellite Auger decay, Physical Review **A** 49 (1994) 4653

Materials Science and Analysis

1. Sarkadi É., Kovács Z., Andó L., C izotóppal jelzett metionin előállítása pozitron emissziós tomográffal végzett vizsgálatokhoz, Izotoptechnika, Diagnosztika **36** (1993) 18
2. Mészáros S., Vad K., Hegman N., Current transfer in grain-boundary junctions of Bi(Pb)SrCaCuO thick films, Physica **C** 218 (1993) 471
3. Kundrák J., Szabó Z., Szücs J., Mahunka I., Vasváry L., Activation technique for "in-process" wear measurement in precision machinery, Archiwum Technologii Maszyn i Automatyzacji (1993) 267
4. Borbély-Kiss I., Fülöp Zs., Gesztelyi T., Kiss Á.Z., Koltay E., Szabó Gy., The PIXE-PIGE method for the classification of late Roman glass sealings, Nuclear Instruments and Methods in Physics Research **B** 85 (1994) 836
5. Vasváry L., Ditrói F., Takács S., Szabó Z., Szücs J., Kundrák J., Mahunka I., Wear measurement of the cutting edge of superhard turning tools using TLA technique, Nuclear Instruments and Methods in Physics Research **B** 85 (1994) 255

6. Kiss Á.Z., Biron, I., Calligaro, T., Salomon, J., Thick target yields of deuteron induced gamma-ray emission from light elements, Nuclear Instruments and Methods in Physics Research **B** 85 (1994) 118
7. Meyer, J.D., Michelmann, R.W., Ditrói F., Bethge, K., Investigation of the electronic energy loss of light ions for materials analysis, Nuclear Instruments and Methods in Physics Research **B** 89 (1994) 186
8. Ditrói F., Meyer, J.D., Michelmann, R.W., Kislat, D., Bethge, K., Investigation of silicon with (p,p') resonance scattering in < 110 > channeling direction, Nuclear Instruments and Methods in Physics Research **B** 89 (1994) 164
9. Solymosi J., Bacsó J., Fehér I., Keömley G., Kónya J., Kuzmann E., Lengyel T., Ormai P., Tóth G., Virágh E., Áttekintés a radioanalitika hazai helyzetéről, Izotoptechnika, Diagnosztika **37** (1994) 39
10. Hegman N., Kiss L.F., Kemény T., Broad peak of the non-linear susceptibility at the spin-glass temperature of amorphous $Fe_{93}Zr_7$, Journal of Physics: Condensed Matter 6 (1994) 427
11. Tőkési K., Kövér L., Varga D., A modified distorted field electrostatic analyzer, Nuclear Instruments and Methods in Physics Research **A** 348 (1994) 173
12. Kövér L., Némethy A., Cserny I., Nisawa, A., Ito, Y., Adachi, H., Local electronic structures in phosphorus oxyanions, Surface and Interface Analysis **22** (1994) 45
13. Kövér L., Némethy A., Barna P.B., Adamik M., Surface structure of Al-Sn layered systems codeposited in the presence of oxygen, Surface and Interface Analysis 22 (1994) 314
14. Kálmán E., Kármán F.H., Cserny I., Kövér L., Telegdi J., Varga D., The effect of calcium ions on the adsorption of phosphoric acid: a comparative investigation with emphasis on surface analytical methods, Electrochimica Acta **39** (1994) 1179
15. Futó I., Degn, H., Effect of sample pressure on membrane inlet mass spectrometry, Analytica Chimica Acta 294 (1994) 177
16. Tholance, J.L., Vad K., et al., Resistive and magnetic anomalies in high Tc cuprates, Physica **C** 235/40 (1994) 1545
17. Mészáros S., Vad K., Halász G., Hegman N., Sas B., Keszei B., Time and spatial correlations in voltages generated by transport current in HTSC materials, Physica **C** 235/40 (1994) 3121

Earth and Cosmic Sciences, Enviromental Research

1. Szöőr Gy., Sümegi P., Hertelendi E., Őshőmérsékleti adatok meghatározása malakohőmérő-módszerrel az Alföld felső pleisztocén-holocén klimaváltozásaival kapcsolatban, Acta Geographica Debrecina **28** (1991) 217
2. Hámor T., Hertelendi E., Az üledékes vasszulfidok delta ^{34}S értéke és az üledékek koradiagenetikus fejlődése közötti kapcsolat, Földtani Közlöny **121** (1991) 133
3. Raczky P., Hertelendi E., Horváth F., Zur Absoluten Datierung der bronzezeitlichen Tell Kulturen in Ungarn, Bronzezeit in Ungarn. Forschungen in Tell-Siedlungen an Donau und Theiss. Ed.:Fodor I.,Meier-Arendt,W.,Raczky P. Frankfurt a.M., Walter Meier Arendt im Auftrag des Dezernats Kultur und Freizeit der Stadt Frankfurt a.M. (1992) 42
4. Pécskay Z., Szakács S., Seghedi, I., Karátson D., Új adatok a Kakukkhegy és szomszédsága (Dél-Hargita, Románia) geokronológiai értelmezéséhez, Földtani Közlöny **122** (1992) 265

5. Scheuer Gy., Szöőr Gy., Sümegi P., Balázs E., Hertelendi E., Schweitzer F., A magyarországi quarter és neogen édesvizi mészkövek termoanalitikai és izotópgeokémiai elemzése facies és rétegtani értékeléssel, Hidrologiai Közlöny **75** (1993) 298
6. Hertelendi E., Lóki J., Sümegi P., A Háy-tanya melletti feltárás rétegsorának szedimentológiai és sztratigráfiai elemzése, Acta Geographica Debrecina **30** (1993) 65
7. El Mahallawi, M., Árva-Sós E., Petrography, geochemistry and K-Ar dating of some metagabbros from the central eastern desert of Egypt, Acta Mineralogica Petrographica, Szeged **34** (1993) 71
8. Harangi Sz., Árva-Sós E., A Mecsek hegység alsókréta vulkáni kőzetei I. Ásvány- és kőzettan, Földtani Közlöny **123** (1993) 129
9. Bilik I., Knezevic, V., Árva-Sós E., Jánosi M., Karamata, S., The spilites of Becici, in the neighbourhood of Budva, initiators of the rifting in Budva-Cukali zone, Ann. Geol. Peninsula Balkan **57** (1993) 215
10. Edelstein, O., Pécskay Z., Kovács, M., Crihán, M., Micle, R., The age of the basalts from Firiza zone Ignis Mts. East Carpathians, Romania, Revue Roumaine de Géologie **37** (1993) 37
11. Szakács A., Seghedi, I., Pécskay Z., Peculiaries of South Harghita Mts. as terminal segment of the Carpathian Neogene to Quaternary volcanic chain, Revue Roumaine de Géologie **37** (1993) 21
12. Koltay E., The application of PIXE and PIGE techniques in the analytics of atmospheric aerosol, Nuclear Instruments and Methods in Physics Research **B** 85 (1994) 75
13. Ali, A.E., Bacsó J., Medve F., Uzonyi I., Seasonal variation of Pb concentration in airborne particles at several sites of Debrecen city, Journal of Radioanalytical and Nuclear Chemistry, Letters **186** (1994) 23
14. Balogh K., Vass, D., Ravasz-Baranyai L., K/Ar ages in the case of correlated K and excess Ar concentrations: a case study for the alkaline olivine basalt of Somoska, Slovak-Hungarian frontier, Geologica Carpathica **45** (1994) 97
15. Shinn, J.L., Wilson, J.W., Badavi, F.F., Benton, E.V., Csige I., Frank, A.L., Benton, E.R., HZE beam transport in multilayered materials, Radiation Measurements **23** (1994) 57
16. Molnár Á., Mészáros E., Koltay E., A léglöri aeroszol részecskék elemi összetételének vizsgálata különböző szennyezettségű környezetben, Egészségtudomány **38** (1994) 235
17. Pamic, J., Pécskay Z., Geochronology of upper Cretaceous and Tertiary igneous rocks from the Slavonija-Srijem Depression (Southern Pannonian Basin) and their basic petrological features, Nafta **45** (1994) 331
18. Ali, A.E., Bacsó J., Trace and major elements in atmospheric deposition in Debrecen city, Journal of Radioanalytical and Nuclear Chemistry, Letters **188** (1994) 199
19. Hakl J., Radontranszport vizsgálatok a Gerecse-hegység barlangjaiban, Komárom-Esztergom megyei Tudományos Szemle (1994) 89
20. Grasselly Gy., Balogh K., Tóth M., Polgári M., K/Ar age of manganese oxide ores of Urkút, Hungary: Ar retention in K-bearing minerals, Geologica Carpathica **45** (1994) 365
21. Hertelendi E., Horváth F., Radiocarbon chronology of Late Neolitic settlements in the Tisza-Maros region, Hungary, Radiocarbon **34** (1992) 859

22. Csige I., Hakl J., Hertelendi E., Hunyadi I., Radioaktivitás a légkörben és környezeti hatásai, Fejezetek a környezetfizikából. Szerk.: Koltay E. Debrecen, KLTE-Atomki Közös Fizikai Tanszék (1994) 70
23. Balogh K., Csige I., Hakl J., Hertelendi E., Hunyadi I., Litoszféra és hidroszféra; A geológiai környezet állapotának vizsgálata, Fejezetek a környezetfizikából. Szerk.: Koltay E. Debrecen, KLTE-Atomki Közös Fizikai Tanszék (1994) 134
24. Koltay E., Fejezetek a környezetfizikából. Egyetemi jegyzet. Szerkesztette: Koltay Ede, KLTE-Atomki Közös Fizikai Tanszék, Debrecen (1994) 247
25. Koltay E., Alternatív energiaforrások fizikai kérdései és perspektívái, Fejezetek a környezetfizikából. Szerk.: Koltay E. Debrecen, KLTE-Atomki Közös Fizikai Tanszék (1994) 229
26. Kovách Á., Globális klimatikai hatások, Fejezetek a környezetfizikából. Szerk.: Koltay E. Debrecen, KLTE-Atomki Közös Fizikai Tanszék (1994) 55
27. Koltay E., Az atomoszféra aeroszol szennyezettsége, Fejezetek a környezetfizikából. Szerk.: Koltay E. Debrecen, KLTE-Atomki Közös Fizikai Tanszék (1994) 27
28. Koltay E., Környezet, kockázat, civilizáció, Fejezetek a környezetfizikából. Szerk.: Koltay E. Debrecen, KLTE-Atomki Közös Fizikai Tanszék (1994) 9
29. Ali A.E., Borbély-Kiss I., Szabó Gy., Koltay E., Medve F., Bacsó J., PIXE analysis of trace and major elements in atmospheric aerosol particles at three different sites of Debrecen city, Hungary, International J. of PIXE, **4** (1994) 997

Biological and Medical Research

1. Szűcs Z., Szelecsényi F., Bergman, J., Heselius, S.-J., Solin, O., ^{3}He-induced nuclear reactions on ^{209}Bi at particle energies less than 28MeV. Production of ^{209}At, Radiochimica Acta **65** (1994) 87
2. Nagy K., Dajkó G., Uray I., Zs.-Nagy I., Comparative studies on the free radical scavenger properties of two nootropic drugs, CPH and BCE-001, Ann. N.Y. Acad. Sci. **717** (1994) 115

Development of Instruments and Methods

1. Pál K.F., Selection schemes with spatial isolation for genetic optimization, Parallel problem solving from nature - PPSN III. Ed.: Y.Davidor, H-P.Schwefel, R. Manner. Berlin, Heidelberg, Springer-Verlag (Lecture Notes in Computer Science, 866) (1994) 170
2. Bodon P., Molnár J., Szili B., Terstyanszki G., Sistema nakopleniya i obrabotki dannykh gamma - spektrometra s pomoshch'yu professional'noj personal'noj vychislitel'noj mashiny pri nejtronnoaktivatsionnom analize, Publications of the University of Miskolc, Mech.Eng.Ser.C. **44** (1993) 115
3. Máthé Gy., Gázexpanziós hűtőrendszerre alapozott REA mérőfej kifejlesztése, Atomki - OMFB (1993) 6
4. Molnár J., Székely G., Lindblad, Th., Lindsey, C.S., Denby, B., Amendolia, S.R., Eide, Á., A flexible VME-module with a 68070 computer for embedded applications of the BO170NX analog neural network chip, ICFA International Bulletin, **10** (1993) 24

5. Kormány Z., A new method and apparatus for measuring the mean energy of cyclotron beams, Nuclear Instruments and Methods in Physics Research **A** 337 (1994) 258
6. Záborszky L., A fiziológiai hangerőszabályozás, Rádiotechnika **44** (1994) 167
7. Záborszky L., Mozgás-visszacsatolás a QUAD-405 erősítőhöz, Rádiotechnika **44** (1994) 223
8. Záborszky L., Mozgás-visszacsatolás a QUAD-405 erősítőhöz. II, Rádiotechnika **44** (1994) 271
9. Záborszky L., Még egyszer a mozgás-visszacsatolásról, Rádiotechnika **44** (1994) 332
10. Svingor É., Mágneses tömegspektrométer vezérlése és a mérési adatok kiértékelése, IBM PC alapú mérésadatgyüjtés, folyamatirányítás, ipari PC alkalmazási példák. Szerk.: Mihály László, Katona Péter., Bp., Selectrade Computer (1994) 8
11. Kalinka G., Entrance window structure of a Si(Li) detector, Nuclear Instruments and Methods in Physics Research **B** 88 (1994) 470
12. Vámosi J., Biri S., TrapCAD - a tool to design and study magnetic traps of ECR ion sources, Nuclear Instruments and Methods in Physics Research **B** 94 (1994) 297
13. Lindsey, C.S., Lindblad, Th., Vollaro, J.R., Székely G., Molnár J., Performance of a cascadable neural network VME-module with Intel 80170NX chips, Nuclear Instruments and Methods in Physics Research **A** 351 (1994) 466
14. Lindblad, Th., Johansson, F., Kallberg, A., Lindsey, C.S., Rosengard, U., Székely G., On the possibilities of using edge detector algorithms for beam spot diagnostics of accelerator beams, Nuclear Instruments and Methods in Physics Research **A** 351 (1994) 595
15. Mészáros S., Vad K., Some problems with HTSC in low-frequency electric and magnetic measurements, Active and Passive Electronic Components, **15** (1993) 225.

Conference Contributions, Talks, Reports

Nuclear Physics

1. Cseh J., Heavy ion resonances and cold fission in terms of multichannel dynamical symmetries, Proccedings of the 7^{th} International Conference on Nuclear Reaction. Mechanisms. Varenna, June 6-11, 1994. Ed.: E.Gadioli. Milano, Universitá degli Studi de Milano. Supplemento N.100 (1994) 222
2. Lévai G., Solvable potentials derived from supersymmetrical quantum mechanics, Quantum inversion theory and applications. Proceedings, Bad Honnef, Germany 1993. Ed.: H.V. von Geramb. Lecture Notes in Physics. Berlin, etc. Springer-Verlag 427 (1993) 107
3. Fülöp Zs., Kiss Á.Z., Somorjai E., Rolfs, C., Trautvetter, H.P., Oberhummer, H., The reaction ^{70}Ge$(\alpha,\gamma)^{74}$Se(p-process), Proceedings of the European Workshop on Heavy Element Nucleosynthesis. Budapest, Hungary. March 9-11,1994. Eds: E. Somorjai, Zs. Fülöp. Debrecen, Atomki (1994) 86
4. Dombrádi Zs., Brant, S., Paar, V., Core polarization induced and detected by quasi-particle in In and Sb nuclei, Proceedings of the 8^{th} International Symposium on Capture Gamma-Ray Spectroscopy and Related Topics. Fribourg, Switzerland, 20-24 Sept., 1993, Ed.: J. Kern,. Word Scientific, Singapore (1994) 146
5. Somorjai E., Fülöp Zs., Proceedings of the European Workshop on Heavy Element Nucleosynthesis. March 9-11,1994. Budapest, Hungary. Eds.: E.Somorjai, Zs.Fülöp. Atomki, Debrecen (1994) 186
6. Mohr, P., Abele, H., Atzrott, U., Staudt, G., Bieber, R., Grün, K., Oberhummer, H., Rauscher, T., Somorjai E., Systematics of alpha-nucleus optical potentials, Proceedings of the European Workshop on Heavy Element Nucleosynthesis. Budapest, Hungary. March 9-11,1994. Eds: E. Somorjai, Zs. Fülöp. Debrecen, Atomki (1994) 176
7. Papp Z., Coulomb Sturmian expansion approach to the Faddeev equation with Coulomb interaction (Contributed paper p.182), XIV European Conference on Few-Body Systems in Physics. Amsterdam, The Netherlands, 23-27 Aug.,1993. (1993)
8. Csótó A., Beta-delayed deuteron emission from ^{6}He, California Institute of Technology, W.K. Kellogg Radiation Laboratory, Pasadena, California, USA. Nov. 17, 1993. (1993)
9. Vertse T., The decay of giant resonances, NORDITA/NorFA Study Weekend on Halo Nuclei, Copenhagen, Denmark, Jan. 28-30, 1994. (1994)
10. Lévai G., A possible generalization of the harmonic oscillator potential Second Workshop on Hadronic Oscillators (HO-II). Cocoyoc, Mexico, 23-25 March, 1994. (1994)
11. Lévai G., Cseh J., An algebraic cluster model based on the harmonic oscillator basis, Second Workshop on Hadronic Oscillators (HO-II). Cocoyoc, Mexico, 23-25 March, 1994. (1994)

12. Ditrói F., Fenyvesi A., Takács S., Tárkányi F., Bergman, J., Heselius, S.-J., Solin, O., Measurement of excitation function of ^{nat}B(p,x)^{7}Be nuclear reaction. (Book of abstr. ORNL, 1994, C22), International Conference on Nulcear Data for Science and Technology. Gatlinurg, Tennessee, USA. 9-13 May,1994. (1994)

13. Szelecsényi F., Boothe, T.E., Tavano, E., Plitnikas, M., Feijoo, Y., Takács S., Tárkányi F., Szűcs Z., New cross section data for ^{66,67,68}Zn+p reactions up to 26 MeV (Book of abstr., ORNL, 1994, D20), International Conference on Nulcear Data for Science and Technology. Gatlinurg, Tennessee, USA. 9-13 May,1994. (1994)

14. Szelecsényi F., Boothe, T.E., Tavano, E., Plitnikas, M., Feijoo, Y., Takács S., Molnár T., Tárkányi F., Compilation and evaluation of cross sections / thick target yields for ^{111}In production(Book of abstr., ORNL, 1994, B39), International Conference on Nulcear Data for Science and Technology. Gatlinurg, Tennessee, USA. 9-13 May,1994. (1994)

15. Qaim, S.M., Rösch, F., Scholten, B., Stöcklin, G., Kovács Z., Tárkányi F., Nuclear data relevant to the production of medically important β^+ emitting radioisotopes ^{75}Br, ^{86}Y, ^{94m}Tc and ^{124}I at a small cyclotron (Book of abstr., ORNL, 1994, 15B.1), International Conference on Nulcear Data for Science and Technology. Gatlinurg, Tennessee, USA. 9-13 May,1994. (1994)

16. Fenyvesi A., Tárkányi F., Szelecsényi F., Takács S., Szűcs Z., Molnár T., Sudár S., Measurement of excitation function and thick target yield of the ^{40}Ar(α,p)^{43}K reaction (Book of abstr. ORNL, 1994, C21), International Conference on Nulcear Data for Science and Technology. Gatlinurg, Tennessee, USA. 9-13 May,1994. (1994)

17. Tárkányi F., Atomki program on measurements compilation and evaluation of integral data of charged particle induced reactions, IAEA Specialists' Meeting on Charged Particle and Photonuclear Data Evaluation for FENDL. Smolenice, Slovakia, 18-21 April, 1994. (1994)

18. Tárkányi F., Status of the Debrecen Nuclear Data Group, IAEA Advisory Group Meeting on the Co-ordination of the Nuclear Reaction Data Centers. Paris, France, 25-27 April, 1994. (1994)

19. Dombrádi Zs., Fényes T., Gácsi Z., Gulyás J., Brandt, S., Paar, V., Structure of odd-odd Sb nuclei, International Conference on Perspectives for the Interacting Boson Model on the Occasion of Its 20^{th} Anniversary. Padova, Italy. 13-17 June, 1994. (1994)

20. Fényes T., Algora, A., Podolyák Zs., Sohler D., Timár J., Paar, V., Brandt, S., Simicic, Lj., Structure of odd-odd Ga and As nuclei, dynamical and supersymmetries, International Conference on Perspectives for the Interacting Boson Model on the Occasion of Its 20^{th} Anniversary. Padova, Italy. 13-17 June, 1994. (1994)

21. Cseh J., Lévai G, Scheid, W., Interacting boson techniques in cluster studies, International Conference on Perspectives for the Interacting Boson Model. Padova, Italy, 13-17 June, 1994. (1994)

22. Cseh J., Multichannel dynamical symmetries and the heavy ion resonances, Institut für Theoretische Physik der Justus-Liebing Universitat, Giessen, Germany. Giessen, Germany, May 13, 1994. (1994)

23. Cseh J., Heavy ion resonances and cold fission in terms of multichannel dynamical symmetries, 7^{th} International Conference on Nuclear Reaction Mechanisms. Varenna, Italy, 6-11 June, 1994. (1994)

24. Beaumel, D., Krasznahorkay A., et al., Decay modes of high-lying single-particle states (Abstr.:JINR, Dubna, E4-94-168, p. 2o), IV. International Conference on Selected Topics in Nuclear Structure. Dubna, Russia, 5-9 July, 1994. (1994)
25. Krasznahorkay A., Harakeh, M.N., Van der Woude, A., Csatlós M., Dombrádi Zs., Kruppa A.T., Máté Z., Sohler D., Excitation of the isovector GDR inelastic alpha-sattering and the neutron skin of nuclei (Abstr.: JINR, Dubna, E4-94-168 p.65), IV. International Conference on Selected Topics in Nuclear Structure. Dubna,Russia, 5-9 July, 1994. (1994)
26. Cseh J., Lévai G., Group theoretical approaches to nuclear cluster structures, Yukawa Institute, Kyoto, Japan, 11. July, 1994. (1994)
27. Cseh J., Lévai G., Group theoretical description of nuclear clusterization, XX^{th} International Colloquium on Group Theoretical Methods in Physics. Toyonaka, Japan, 4-9 July, 1994. (1994)
28. Cseh J., Heavy-ion resonances and cold fission in terms of multichannel dynamical symmetries, Hokkaido University, Department of Physics, Sapporo, Japan, 14 July, 1994. (1994)
29. Bentley, M A , Nyakó B.M., et al., Search for linking transitions between the superdeformed and normal deformed states in ^{152}Dy using Eurogam (Contributions. LBL-35687 p.23), Conference on Physics from Large Gamma-Ray Detector Arrays. Clark Kerr Campus, Berkeley, USA, 2-6 Aug.,1994. (1994)
30. Somorjai E., Electron screening in the laboratory: Status quo of measurement, Summer Institute on Nuclear Physics and Astrophysics. Gran Sasso, Italy, 27 June - 7 July, 1994. (1994)
31 Fülöp Zs., Kiss Á.Z., Somorjai E., Rolfs, C., Trautvetter, H.P., Rauscher, T., Oberhummer, H., The reaction ^{70}Ge$(\alpha,\gamma)^{74}$Se (p-process), Third International Symposium on Nuclear Astrophysics, "Nuclei in the Cosmos" Gran Sasso, Italy, 8-13 July, 1994. (1994)
32. Cseh J., Dynamic and kinematic breaking of symmetries in algebraic models, Institut für Theoretische Physik, Justus-Liebig-Universität. Giessen, Germany. Aug. 25, 1994. (1994)
33. Cseh J., Sokcsatornás dinamikai szimmetriák és klaszterizáció (Abstr.), XII. Magyar Magfizikus Találkozó. Debrecen, Magyarország, 1994. augusztus 29-31. (1994)
34. Lévai G., Szuperszimmetrikus kvantummechanika az atommagfizikában. (Abstr), XII. Magyar Magfizikus Találkozó. Debrecen, Magyarország, 1994. augusztus 29-31. (1994)
35. Somorjai E., Elektron árnyékolás az asztrofizikában ma. (Abstr.), XII. Magyar Magfizikus Találkozó. Debrecen, Magyarország, 1994. augusztus 29-31. (1994)
36. Rajta I., Elemösszetevők meghatározása tengeri kagylók héjának metszetében pásztázó proton mikroszondával. (Abstr.), XII. Magyar Magfizikus Találkozó. Debrecen, Magyarország, 1994. augusztus 29-31. (1994)
37. Török I., Papp T., Pálinkás J., Budnar, M., Mühleisen, A., Kawai, J., A $K\beta_5$ röntgen vonal relativ intenzitása a kibocsátó elem rendszáma függvényében (Abstr.), XII. Magyar Magfizikus Találkozó. Debrecen, Magyarország, 1994. augusztus 29-31. (1994)
38. Dankó I., Fayez F.M. Hassan, M., Gulyás J., A páratlan-páratlan jód atommagok spektroszkópiája. (Abstr.), XII. Magyar Magfizikus Találkozó. Debrecen, Magyarország, 1994. augusztus 29-31. (1994)

39. Kruppa A.T., Pál K.F., Rowley, N., Energiaszintek statisztikai analizise: káosz a részecske-rotor modellben (Abstr.), XII. Magyar Magfizikus Találkozó. Debrecen, Magyarország, 1994. augusztus 29-31. (1994)
40. Fényes T., Algora, A., Podolyák Zs., Sohler D., Timár J., Paar, V., Brant, S., Simicic, Lj., A Ga és As atommagok szerkezete, dinamikus és szuperszimmetriák (Abstr.), XII. Magyar Magfizikus Találkozó. Debrecen, Magyarország, 1994. augusztus 29-31. (1994)
41. Fülöp Zs., Kiss Á.Z., Somorjai E., Rolfs, C., Rautvetter, H.R., Oberhummer, H., Sugárzásos befogási reakciók szerepe a nehéz elemek szintézisében (Abstr.), XII. Magyar Magfizikus Találkozó. Debrecen, Magyarország, 1994. augusztus 29-31. (1994)
42. Podolyák Zs., Sohler D., Algora, A., Fényes T., A ^{70,72,74}As atommagok gerjesztési nívói. (Abstr.), XII. Magyar Magfizikus Találkozó. Debrecen, Magyarország, 1994. augusztus 29-31. (1994)
43. Krasznahorkay A., Egy split-pole tipusú mágneses spektrográf telepítése az Atomkiben, első eredmények. (Abstr.), XII. Magyar Magfizikus Találkozó. Debrecen, Magyarország, 1994. augusztus 29-31. (1994)
44. Zolnai L., Nyakó B.M., Józsa M., EUROGAM Coll., Gerjesztett szuperdeformált sávok a ^{132}Ce magban (Abstr.), XII. Magyar Magfizikus Találkozó. Debrecen, Magyarország, 1994. augusztus 29-31. (1994)
45. Perez Lopez, G.E., Nyakó B.M., Dombrádi Zs., NORDBALL Coll., Az erősen neutron-hiányos ^{108,109}Te és ^{110}Te magok azonosítása NORDBALL detektorrendszerrel (Abstr.), XII. Magyar Magfizikus Találkozó. Debrecen, Magyarország, 1994. augusztus 29-31. (1994)
46. Santos, D., Józsa M., Nyakó B.M., Zolnai L., et al., Excited *sd* bands in ^{132}Ce and the pseudo-spin scheme (Abstract of SELMA94 Stockholm. p. 1994), New Nuclear Structure Phenomena in the Vincity of Closed Shells, SELMA94. Stockholm-Uppsala, Sweden, Aug. 30 - Sept. 3, 1994. (1994)
47. Csótó A., Three-body resonances by complex scaling (Contributed papers pp. 777-780), XIVth International Conference on few-body problems in physics. Williamsburg, Virginia, USA. 26-31 May, 1994. (1994)
48. Csótó A., Three-body resonances, Los Alamos National Laboratory, Theory Division. Los Alamos, New Mexico, USA. March 1, 1994. (1994)
49. Csótó A., The solar neutrino problem, New Mexico State University, Las Cruces, New Mexico, USA. March 3, 1994. (1994)
50. Csótó A., Nuclei far from stability, California Institute of Technology, W.K. Kellogg Radiation Laboratory, Pasadena, California, USA. March 30, 1994. (1994)
51. Varga K., Lovas R.G., Suzuki, Y., Microscopic multicluster description of neutron halo, Conference of HALO'94. Copenhagen, Denmark, Jan. 28-30, 1994. (1994)
52. Csótó A., Prime number statistics and quantum chaos, California Institute of Technology, W.K. Kellogg Radiation Laboratory, Pasadena, California, USA. Jan. 25, 1994. (1994)
53. Csótó A., Neutron halo structure of ^{6}He, National Superconducting Cyclotron Laboratory, Michigan State University. Est Lansing, Michigan, USA. Aug. 25, 1994. (1994)
54. Nyakó B.M., Dombrádi Zs., Józsa M., Perez Lopez, G.E., et al., Identification and spectroscopy of ^{108,109,110}Te nuclei (Contributions LBL-35687 p.51), Conference on Physics from Large Gamma-Ray Detector Arrays. Clark Kerr Campus, Berkeley, USA, 2-6 Aug., 1994. (1994)

55. Vivien, J.P. , Nyakó B.M., et al., Neutron excitations in ^{147}Gd superdeformed nucleus Contributions LBL-35687 p.15), Conference on Physics from Large Gamma-Ray Detector Arrays. Clark Kerr Campus, Berkeley, USA, 2-6 Aug.,1994. (1994)
56. Gizon, J., Józsa M., Nyakó B.M., Zolnai L., et al., Configurations of excited *sd* bands in ^{132}Ce and identical bands in the mass 130 region (Contributions LBL-35687 p.5), Conference on Physics from Large Gamma-Ray Detector Arrays. Clark Kerr Campus, Berkeley, USA, 2-6 Aug., 1994. (1994)
57. Nolan, P.J., Nyakó B.M., Zolnai L., et al., Three identical degenerate bands in the second minimum in ^{131}Ce (Contributions LBL-35687 p.3), Conference on Physics from Large Gamma-Ray Detector Arrays. Clark Kerr Campus, Berkeley, USA, 2-6 Aug., 1994. (1994)
58. Cseh J., Lévai G., Different aspects of clusterization within a semimicroscopic algebraic model (Contributed Papers. Ed.:F.Haas, p.49), Clusters in Nuclear Structure and Dynamics. Strasbourg, France, 6-9 Sept., 1994. (1994)
59. Lévai G., Algebraic models of nuclear clusterization, GANIL (Grand Accelerateur National d'Ions Lourds), Cean, France. Sept. 16, 1994. (1994)
60. Dombrádi Zs., Sohler D., Brant, S., Paar, V., Micro-deformation in the Sn region, New Nuclear Structure Phenomena in the Vincity of Closed Shells, SELMA94. Stockholm-Uppsala, Sweden, Aug. 30 - Sept. 3, 1994. (1994)
61. Dombrádi Zs., Podolyák Zs., Brant, S., Paar, V., Effective proton-neutron interaction in the singly closed shell region, New Nuclear Structure Phenomena in the Vicinity of Closed Shells, SELMA94. Stockholm-Uppsala, Sweden, Aug. 30 - Sept. 3, 1994. (1994)
62. Dombrádi Zs., Algora, A., Brant, S., Paar, V., Proton-neutron multiplet states in ^{100,102}In, New Nuclear Structure Phenomena in the Vicinity of Closed Shells, SELMA94. Stockholm-Uppsala, Sweden, Aug. 30 - Sept. 3, 1994. (1994)
63. Ditrói F., Takács S., Tárkányi F., Fenyvesi A., Szelecsényi F., Investigation of the charged particle nuclear reactions on natural Boron for the purposes of thin layer activation (TLA), 13^{th} International Conference on the Application of Accelerators in Research and Industry. Denton, Texas, USA, 7-10 Nov., 1994. (1994)
64. Ditrói F., Takács S., Tárkányi F., Mahunka I., Study of the ^{nat}C(^{3}He,2α)^{7}Be and ^{9}Be(^{3}He,αn)^{7}Be nuclear reactions and their applications for wear measurements, 13^{th} International Conference on the Application of Accelerators in Research and Industry. Denton, Texas, USA, 7-10 Nov., 1994. (1994)
65. Ditrói F., Meyer, I., Michelmann, R., Bethge, K., Computer simulation of channeling in Si and GaAs crystals (Book of Abstracts p.65), 13^{th} International Conference on the Application of Accelerators in Research and Industry. Denton, Texas, USA, 7-10 Nov., 1994. (1994)
66. Meyer, I., Michelmann, R., Ditrói F., Bethge, K., Nuclear reaction channeling, 13^{th} International Conference on the Application of Accelerators in Research and Industry. Denton, Texas, USA, 7-10 Nov., 1994. (1994)
67. Lévai G., Dynamical symmetries of quantum mechanical potentials, Institut für Theoretische Physik, Justus-Liebig-Universität, Giessen, Germany, Dec.9, 1994. (1994)
68. Somorjai E., Rolfs, C., Status report on electron screening, 13^{th} International Conference on the Application of Accelerators in Research and Industry. Denton, Texas, USA, 7-10 Nov., 1994. (1994)
69. Nyakó B.M., Dombrádi Zs., Józsa M., Perez Lopez, G.E., et al., Identification and spectroscopy of ^{108,109,110}Te nuclei, New Nuclear Structure Phenomena in the

Vicinity of Closed Shells, SELMA94. Stockholm-Uppsala, Sweden, 30. Aug. - 3. Sept., 1994 (1994)
70. Nyakó B.M., Gál J., The chess-board CsI-detector and its electronics, EUROBALL Users Meeting. Strasbourg, France, 19-23 Sept., 1994. (1994)
71. Lovas R.G., Antisymmetrization in cluster-decay problems, I.N.F.N., Sezione di Catania. Catania, Italy, Oct. 4, 1994. (1994)
72. Lovas R.G., Microscopic description of alpha-decay, I.N.F.N., Sezione di Catania. Catania, Italy, Oct. 3, 1994. (1994)
73. Varga K., Lovas R.G., Liotta, R. J., Microscopic description of alpha-decay on spatially extensive bases (Contributed papers, p.36), Sixth International Conference on Clusters in Nuclear Structure and Dynamics. Strasbourg, France, 6-9 Sept., 1994. (1994)
74. Lovas R.G., Conference summary: the theoretical point of view, Sixth International Conference on Clusters in Nuclear Structure and Dynamics. Strasbourg, France, 6-9 Sept., 1994. (1994)
75. Csótó A., Lovas R.G., Kruppa A.T., RGM on the complex k-plane: shadow pole in the $3/2^+$ resonance of ^{5}He (Contributed papers, p.40), Sixth International Conference on Clusters in Nuclear Structure and Dynamics. Strasbourg, France, 6-9 Sept., 1994. (1994)
76. Lovas R.G., Nukleoncsomók atommagokban, XXXVII. Országos Középiskolai Fizikatanári Ankét. Debrecen, Magyarország, 1994. ápr. 7-9. (1994)
77. Fényes T., Magyar Magfizikus Találkozó - 1994, Fizikai Szemle **44** (1994) 371

Atomic Physics

1. Szabó Gy., Wang, J., Burgdörfer, J., Ellipsoidal angular distributions of electrons emitted from Rydberg atoms(14. Arbeitsbericht EAS-14 (1993) p.94) Arbeitsgruppe Energiereiche Atomare Stösse. Riezlern, Germany, 1993. (1993)
2. Moxom, J., Laricchia, G., Chalton, M., Jones, G.O., Kövér Á., Post collision interraction in positron atom collisions, (Abstract of Contributed Paper p.400), XVIIIth International Conference on the Physics of Electronic and Atomic Collisions. Aarhus, Denmark, 21-27 July, 1993. (1993)
3. Kövér Á., Laricchia, G., Chalton, M., Differention ionisation studies at forward angles (Book of Abstracts p. 15), International Workshop on Positron Interraction with Atoms, Molecules and Clusters. Bielefeld, Germany, July 14-16, 1993. (1993)
4. Laricchia, G., Moxom, J., Chalton, M., Kövér Á., Meyerhof, W.E., Near threshold effects in positron-atom (molecule) scattering (Book of Abstracts p.14), International Workshop on Positron Interraction with Atoms, Molecules and Cluster'. Bielefeld, Germany, July 14-16, 1993. (1993)
5. Víkor L., Construction of an electrostatic lens for an electron spectrometer and study of autoionization lines, Institut für Kernphysik J.W.Goethe Universität Frankfurt a.M. Frankfurt a.M., Germany. Nov. 23, 1993. (1993)
6. Berényi D., Present actual topics and trends in atomic physics, Babes-Bolyai Univ., Cluj-Napoca, Romania, Oct. 26, 1993. (1993)
7. Török I., Wavelenght dispersive X-ray spectrometry in the Atomki, Institut "Jozef Stefan" (Univerza v Ljubljani). Ljubljana, Slovenija, March 31, 1994. (1994)

8. Papp T., Campbell, J.L., Line-shape effects on the determination of L and M subshell ionization cross sections (Abstr. p.68), European Conference on Energy Dispersive X-Ray Spectroscopy. Budapest, Hungary. 30 May - 3 June, 1994. (1994)
9. Papp T., Török I., Pálinkás J., On the Z dependence of the relative intensity of the $K\beta_5$ (K-M IV,V) transition (Abstr. p.66), European Conference on Energy Dispersive X-Ray Spectroscopy. Budapest, Hungary. 30 May - 3 June, 1994. (1994)
10. Papp T., Angular distribution of fluorescent x-rays following photoionization (Abstr. p. 69), European Conference on Energy Dispersive X-Ray Spectroscopy. Budapest, Hungary. 30 May - 3 June, 1994. (1994)
11. Papp T., Kalinka G., Modelling of in-sample scattering of fluorescent x-rays (Abstr. p.24), European Conference on Energy Dispersive X-Ray Spectroscopy. Budapest, Hungary. 30 May - 3 June, 1994. (1994)
12. Papp T., Újszerű atomfizikai vizsgálatok magfizikai laboratóriumokban, Fizikatanári Ankét. Debrecen, Magyarország. 1994. április 7-9. (1994)
13. Sarkadi L., Study of atomic collisions by detection of electrons, Departamento de Física, Universidade de Lisboa. Lisboa, Portugal. Febr. 9, 1994. (1994)
14. Sarkadi L., Ejection of electrons from energetic atomic collisions, Laboratoire de Dynamique Moléculaire et Atomique, Université Pierre et Marie Curie. Paris, France. Apr. 28, 1994. (1994)
15. Kövér Á., Ion-atom collisions and positron scattering differential study, Department of Physics, University College London. London, U.K. March 23, 1994. (1994)
16. Kövér Á., Coincidence experiments in atomic collisions, Consiglio Nazionale delle Ricerche, Istituto di Metodologie Avanzate Inorganiche. Roma, Montelibretti, Italy. Apr. 12, 1994. (1994)
17. Kövér Á., Atomfizika - antirészecskékkel, Miskolci Nehézipari Egyetem, Fizikai Tanszék. Miskolc, Magyarország. 1994. február 23 (1994)
18. Báder A., An ion detector for atomic physical applications, Institut fur Kernphysik, Frankfurt/Main, Germany. Apr. 26, 1994. (1994)
19. Víkor Gy., Tóth L., Ricz S., Pelicon, P., Sulik B., Végh J., Kövér Á., Measurements of angular dependence of post collision interaction in ion-atom collisions at medium energies (Energiereiche Atomare Stösse EAS-15, 15. Arbeitsbericht Darmstadt, GSI, 1994 p. 29), Energiereiche Atomare Stösse, EAS-15. Kassel, Germany, 27. Jan., 1994. (1994)
20. Finck, R., Kövér Á., Charlton, M., Laricchia, G., The angular dependence of positronium formation in positron-argon collisions (Book of Abstr.: p.87), 4^{th} National Conference on Atomic, Molecular and Optical Physics. Brighton, UK. 11-14 April, 1994. (1994)
21. Víkor Gy., Tóth L., Ricz S., Kövér Á., Végh J., Extensions for the ESA-21 electron spectrometer (Contributed Papers, Beograde, Institute of Physics p.59), 17^{th} Summer School and International Symposium on the Physics of Ionized Gases. Beograde, Yugoslavia, Aug. 29 - Sept. 1. (1994)
22. Tőkési K., Mukoyama, T., Theoretical investigation of the ECC peak for charged particles with the CTMC method, Bulletin of the Institute for Chemical Research, Kyoto University **72** (1994) 62
23. Berényi D., Ion-atom collisions in radiation physics. Invited talk, 6^{th} Int. Symp. on Rad. Phys. ISRP-6. Rabat, Moroco, July 18-22, 1994. (1994)
24. Kövér L., Cserny I., Némethy A., Sanjines, C., Coluzza, C., Margaritondo, G., Adachi, H., P LVV Auger- and high resolution valence band XPS spectra of phosphorus oxyanions(IWASES III, Book of Abstracts), Third International workshop

on Auger Spectroscopy and Electronic Structure IWASES III. Liverpool, United Kingdom, 4-8 Sept, 1994. (1994)

25. Víkor Gy., Tóth L., Ricz S., Kövér Á., Végh J., Coincidence study of Ne KLL Auger at the 1.5MeV proton bombardment (IWASES III, Book of Abstracts P44), Third International workshop on Auger Spectroscopy and Electronic Structure IWASES III. Liverpool, United Kingdom, 4-8 Sept, 1994. (1994)
26. Némethy A., Kövér L., Cserny I., Varga D., Barna P.B., KL2,3L2,3 Auger spectra of MnO and metallic Mn (IWASES III. Book of abstracts), Third International workshop on Auger Spectroscopy and Electronic Structure IWASES III. Liverpool, United Kingdom, 4-8 Sept, 1994. (1994)
27. Cserny I., Kövér L., Némethy A., Adachi, H., Tanaka, I., Nisawa, A., Ito, Y., Sanjines, C., Coluzza, C., Margaritondo, G., Local electronic structure of phosphorus oxyanions, Osaka Electro-Communication University, Neyagawa, Osaka, Japan. May 17, 1994. (1994)
28. Kövér L., Kovács Zs., Weightman, P., Varga D., Pálinkás J., Adachi, H., The influence of the NiD band on the local Al density of states in Al_3Ni and $AlNi_3$ alloys: A study of Auger and core level spectra, Third International workshop on Auger Spectroscopy and Electronic ructure IWASES III. Liverpool, United Kingdom, 4-8 Sept, 1994. (1994)
29. Kovács Zs., Kövér L., Varga D., Weightman, P., Pálinkás J., Adachi, H., Core-valence (KLV,KVV,LVV) Auger and high resolution valence band XPS spectra of aluminium: a comparison with the results of cluster MO calculations, Third International workshop on Auger Spectroscopy and Electronic ructure IWASES III. Liverpool, United Kingdom, 4-8 Sept, 1994. (1994)
30. Kovács Zs., Kövér L., Varga D., Weightman, P., Sanjines, C., Margaritondo, G., Pálinkás J., Adachi, H., Effects of oxygen chemisorption on K-valence Auger and valence band photoemission spectra of Al, Third International workshop on Auger Spectroscopy and Electronic ructure IWASES III. Liverpool, United Kingdom, 4-8 Sept, 1994. (1994)
31. Kövér L., Kovács Zs., Sanjines, C., Moretti, G., Cserny I., Margaritondo, G., Pálinkás J., Adachi, H., Electronic structure of tin oxides: a high resolution study of XPS and Auger spectra (Conf Abstr. p.75), 8^{th} International Conference on Quantitative Surface Analysis, Guildford, U.K. 23-26 Aug., 1994. (1994)
32. Cserny I., Kövér L., Némethy A., Adachi, H., Tanaka, I., Sanjines, C., Coluzza, C., Margaritondo, G., A relalistic cluster approach for interpreting the valence band structure of phosphorus oxyanions (Conf. Abstr., p. 58), 8^{th} International Conference on Quantitative Surface Analysis, Guildford, U.K. 23-26 Aug., 1994. (1994)
33. Tőkési K., Hock G., Electron capture in He^{2+}+He collisions up to 1500 KeV/amu projectile impact (TU23), 7^{th} International Conference on the Physics of Highly Charged Ions. Vienna, Austria, 19-23 Sept., 1994. (1994)
34. Dörner, R., Tőkési K., et al., Electron electron interaction in projectile ionisation (WE17), 7^{th} International Conference on the Physics of Highly Charged Ions. Vienna, Austria, 19-23 Sept., 1994. (1994)
35. Wang, J., Olson, R.E., Tőkési K., Burgdörfer, J., Reinhold, C.O., Ionization by structured particle impact, VI^{th} International Conference on the Physics of Highly Charged Ions. Kansas, USA, Sept. 28 - Oct. 2, 1992. Ed.:P.Richard, M.Stöckli, C.L.Cocke C.D.Lin. Manhattan, KS. (AIP Conference Proceedings 274) (1992) 271

36. Tőkési K., Wang, J., Olson, R.E., Effects of electron-electron interaction in ionization by structured particle impact (TU22), 7^{th} International Conference on the Physics of Highly Charged Ions. Vienna, Austria, 19-23 Sept., 1994. (1994)
37. Sulik B., Ricz S., Kádár I., Xiao, G., Schiwietz, G., Sommer, K., Köhrbrück, R., Grether, M., Stolterfoht, N., Two-center electron-electron interactions in collisions of fast Ne^{7+} and Ne^{6+} ions with gas atoms, 7^{th} International Conference on the Physics of Highly Charged Ions. Vienna, Austria, 19-23 Sept., 1994. (1994)
38. Biri S., Vámosi J., The Debrecen-ECRIS: magnetic trap visualisation and particle movement simulation, 29^{th} European Cyclotron Progress Meeting. Dubna, Russia, 20-22 June, 1994. (1994)
39. Biri S., Vámosi J., 2D design and visualisation of complex magnetic traps. (Abstracts of EPAC p.80), 4^{th} European Particle Acceleration Conference. London, UK., 27 June - 1 July, 1994 . (1994)
40. Biri S., Vámosi J., Stiebing, K.E., Schmidt-Böcking, H., Simulation of HCI movement in magnetic traps of ECR ion sources. (Book of Abstracts. Ed.: F. Aumayer, H.P. Winter. p.TU69), 7^{th} International Conference on the Physics of Highly Charged Ions. Vienna, Austria, 19-23 Sept., 1994, (1994)
41. Gulyás L., Fainstiein, P.D., Salin, A., Quantitative two-center effects in single ionization, 7^{th} International Conference on the Physics of Highly Charged Ions. Vienna, Austria, 19-23 Sept., 1994. (1994)
42. Végh J., Data evaluation possibilities using the EWA program, University of Oulu, Department of Physics. Oulu, Finland, 29. April, 1994. (1994)
43. Végh J., The effects of using different approximations to Voigt line shape, University of Oulu. Oulu, Finland, 22 June, 1994. (1994)
44. Ditrói F., Meyer, I., Michelmann, R., Bethge, K., Computer simulation of channeling in Si and GaAs crystals, (Book of Abstracts p.65), 13^{th} International Conference on the Application of Accelerators in Research and Industry. Denton, Texas, USA, 7-10 Nov., 1994. (1994)
45. Meyer, I., Michelmann, R., Ditrói F., Bethge, K., Nuclear reaction channeling, 13^{th} International Conference on the Application of Accelerators in Research and Industry. Denton, Texas, USA, 7-10 Nov., 1994. (1994)
46. Zhee, M., Haas, R., Fergusson, S.M., Woitke, O., Tanis, J.A., Sarkadi L., Pálinkás J., Závodszky, P.A., Berényi D., Cusp-electron production in 0.5-1.5 MeV/u O^{7+}+Ar collisions. (Book of Abstracts, Ed.: F. Aumayr, H.P. Winter. Vienna, 1994, p. M29), 7^{th} International Conference on the Physics of Highly Charged Ions. Vienna, Austria, 19-23 Sept., 1994. (1994)
47. Papp T., Angular distribution of X-rays from multiple ionized atoms, Institute of Physical and Chemical Research. Wako, Japan, Oct. 17, 1994. (1994)
48. Papp T., Spatial and polarisation distribution of characteristic x-rays, Osaka Electrocommunication University. Osaka, Japan, Nov. 18, 1994. (1994)
49. Papp T., Atomic level widths, determined from the XPS, XES and absorbtion edge database, Kyoto University. Kyoto, Japan, Nov. 17, 1994. (1994)
50. Terasawa, M., Török I., Petukhov, V.P., High resolution PIXE instrumentation survey. Part.II. (Abstract for the ... p. 71. No. EB5, p. 105. No. PB38), 13^{th} International Conference on the Application of Accelerators in Research and Industry. Denton, Texas, USA, 7-10 Nov., 1994. (1994)
51. Dörner, R., Tőkési K., et al., State selective capture and projectile ionization measured using recoil ion momentum spectroscopy (Abstr.ID2,189), 13^{th} International

Conference on the Application of Accelerators in Research and Industry. Denton, Texas, USA, 7-10 Nov., 1994. (1994)
52. Prince, K.C., Kövér Á., et al., Gas phase photoemission (GAPH) beamline at ELETTRA, Second Users' Meeting, Trieste, Italy, Dec. 1-2, 1994. (1994)
53. Závodszky, P.A., Sarkadi L., Víkor L., Báder A., Pálinkás J., Berényi D., Tanis, J.A., Kamber, E., Kuzel, M., Esch, M., Krebs, G., Groeneveld, K.O., Transfer ionization ion electron emission from the impact of low energy protons on argon (Abstr. Ed.:Jerome L. Duggan and I. Lon Morgan. 1994, p.155), 13^{th} International Conference on the Application of Accelerators in Research and Industry. Denton, Texas, USA, 7-10 Nov., 1994. (1994)
54. Sarkadi L., Ionization of L subshells at impact of heavy particles, Western Michigan University, Department of Physics. Kalamazoo, Michigan, USA, Nov. 15, 1994. (1994)
55. Víkor Gy., Izucavanje ion-atomskih sudara Auger spektroskopijom, Institut za Fiziku, Beograd, Yugoslavia, Aug. 8, 1994. (1994)
56. Kövér Á., Coincidence studies in atomic collision research, Institut Jozef Stefan, Ljubljana, Slovenia, Nov. 24, 1994. (1994)
57. Berényi D., Röntgensugárzás és belsőhéj-folyamatok. Ujabb eredmények az X'93 (1993.június 12-16.) nemzetközi konferencián, Fizikai Szemle **44** (1994) 331
58. Tőkési K., Monte Carlo methods in atomic physics, Uolun Yliopisto, Fysiikan Laitos, Oulu, Finland, Aug. 20, 1994. (1994)

Materials Science and Analysis

1. Uzonyi I., Szluha K.L., Bacsó J., Determination of Pt concentration in human tissues using XRF, 6^{th} Hungaro-Italian Symposium on Spectrochemistry, Advences in Environmental Sciences. Lillafüred, Hungary, 23-27 Aug., 1993. (1993)
2. Kálmán E., Kármán F.H., Telegdi J., Cserny I., Kövér L., Varga D., Surface analytical investigation of the influence of calcium ions on the adsorption and on the inhibition of phosphonic acid on mild steel, 4^{th} Meeting of the International Society of Electrochemistry. Berlin, Germany, (1993)
3. Sarkadi É., Kovács Z., Andó L., C izotóppal jelzett metionin előállítása pozitron emissziós tomográffal végzett vizsgálatokhoz, MONT 8.kongresszusa. Szeged, Magyarország, 1993. aug. 30 - sept. 1. (1993)
4. Török I., Wavelength dispersive X-ray spectrometry in the Atomki, Institut "Jozef Stefan" (Univerza v Ljubljani). Ljubljana, Slovenija, March 31, 1994. (1994)
5. Bacsó J., MacPherson, A., A haj-Ca és a SMR (Standard Mortality Ration) összefüggésének tanulmányozása angol népességen, MTA Spektrokémiai Munkabizottsági Ankét. Debrecen, 1994. április 7-8. (1994)
6. Kis-Varga M., Classification of ball milled metal powders by X-ray diffractometry, Van der Waals-Zeeman Laboratory, University of Amsterdam. Amsterdam, The Netherlands, Apr. 15, 1994. (1994)
7. Bacsó J., Uzonyi I., Experimental investigation of heterogeneity effects in x-ray fluorescence analysis of hair, European Conference on Energy Dispersive X-Ray Spectrometry. Budapest, Magyarország. May 30 - June 3, 1994. (1994)
8. Hegman N., Vad K., Mészáros S., Halász G., RF to DC conversion in Bi(Pb)Sr-CaCuO screen printed films, Eighth Cimtec World Ceramics Congress, June 30 - July 4, 1994, Firenze, Italy (1994)

9. Mészáros S., Vad K., Halász G., Hegman N., Sas B., Keszei B., Time and spatial correlations in voltages generated by transport current in HTSC materials, 4^{th} International Conference, Materials and Mechanisms of Superconductivity High Temperature Superconductors, M2S-HTSC IV. Grenoble, France, 5-9 July, 1994. (1994)
10. Tholance, J.L., Vad K., et al., Resistive and magnetic anomalies at high temperature in cuprates, 4^{th} International Conference, Materials and Mechanisms of Superconductivity High Temperature Superconductors, M2S-HTSC IV. Grenoble, France, 5-9 July, 1994. (1994)
11. Tőkési K., On the numerical electron optical calculations for CMA and its electron lenses, Oulun Yliopisto, Fysiikan Laitos, Oulu, Finland. Aug. 12, 1994. (1994)
12. Ditrói F., Mahunka I., Wear measurements by using nuclear implantation, Research Co-ordination Meeting on Nuclear Methods in Monitoring Wear and Corrosion in Industry. Obninsk, Russia, 5-9 Sept., 1994. (1994)
13. Mahunka I., Ditrói F., TLA technique based on the cyclotron in Debrecen, Research Co-ordination Meeting on Nuclear Methods in Monitoring Wear and Corrosion in Industry. Obninsk, Russia, 5-9 Sept., 1994. (1994)
14. Tőkési K., Némethy A., Kövér L., Varga D., Mukoyama, T., Modelling of electron scattering in thin manganese films on silicon by Monte Carlo methods, 8^{th} International Conference on Quantitative Surface Analysis, Guildford, U.K. 23-26 Aug., 1994. (1994)
15. Kiss Á.Z., Nukleáris módszerek a múzeumi kutatásban, A Múzeumok Szerepe a Tudományos Életben c. muzeológus tanácskozás. Szolnok, Magyarország. 1994. szeptember 27. (1994)
16. Kiss Á.Z., A pásztázó ion-mikroszonda az analitikai vizsgálatok szolgálatában (Az MTA Szabolcs-Szatmár-Bereg Megyei Tudományos Testületének Közleményei. **19** 1994. 93), Az MTA Szabolcs-Szatmár-Bereg Megyei Tudományos Testülete 1994.évi 3. Közgyülése. Nyiregyháza, Magyarország. 1994.október 1. (1994)
17. Szabó S., Brovko, I., Kis-Varga M., Posgay G., Beke D.L., Mössbauer-effect and magnetic properties of nanocrystalline Fe and Fe(Si) alloys. (Programme and Abstracts p.313), NANO'94 Second International Conference on Nanostructured Materials. Stuttgart, Germany. 3-7. Oct., 1994. (1994)
18. Daróczi L., Beke D.L., Posgay G., Kis-Varga M., Magnetic properties of nanocrystalline Ni and Fe (Programme and Abstracts p.257), NANO'94 Second International Conference on Nanostructured Materials. Stuttgart, Germany. 3-7. Oct., 1994. (1994)
19. Kövér L., Beszámoló az ISO (Nemzetközi Szabványügyi Szervezet) "Felületi Kémiai Analízis" Technikai Bizottságának (TC201) legutóbbi üléséről, Az MTA Szilárdtestfizikai Bizottsága Felületfizikai Albizottságának a Szilárdtest és Felületkémiai Munkabizottságának és a IUVSTA Magyar Nemzeti Bizottságának Együttes Ülése. Budapest, 1994. 1. (1994)
20. Kövér L., Moretti, G., Kovács Zs., Sanjines, C., Cserny I., Margaritondo, G., Pálinkás J., Adachi, H., High resolution photoemission and Auger parameter studies of electronic structure of tin oxides (Final Program and Abstracts, American Vacuum Society, 1994, p.127), 41^{st} National Symposium of the American Vacuum Society and NANO3: Third International Conference on Nanometer-Scale Science and Technology. Denver, USA, 24-28 Oct., 1994. (1994)
21. Vad K., Measurements of electromagnetic properties of HTSC materials, International Committee Meeting. Budapest, Hungary, 20. Oct., 1994. (1994)

23. Kurokawa, A., Ichimura, S., Tóth J., Yoshihara, K., Saito, Y., XHV system designed for atomic layer deposition and surface electron tomography, Japanese Vacuum Conference. Osaka, Japan, 21-25 Oct., 1994. (1994)
24. Berényi D., A szinkrotronsugárzás ipari alkalmazása. Szerk.:Berényi Dénes és Török Szabina, Budapest, Magyar Szinkrotron Bizottság, 1994. (1994) 154

Earth and Cosmic Sciences, Environmental Research

1. Hakl J., Sugárzás az iskolában meg egyebek, Gábor Dénes Műszaki Szakközépiskola. Dunaújváros, Magyarország, 1994. márc. 12. (1994)
2. Balogh K., Dunkl I., K/Ar and fission track dating of metamorphic rocks from the Sopron Mts., Lower Austro-Alpine Unit (Hungary). (Abstr.: Mitt. Öst. Miner. Ges., 139, pp. 26-27.), S47-GEO Meeting. Krems, Austria. 6-10 April, 1994 (1994)
3. Vásárhelyi A., Hakl J., Assessment of radon entry rates based on continuous (and multiparameter) measurements, Nuclear Accident: Management and Impact on Environment and Health. Bucharest, Romania, 25-27 May, 1994. (1994)
4. Hertelendi E., Kalicz N., Raczky P., Horváth F., Veres M., Futó I., Figler A., Bartosiewitz L., Re-evolution of the Neolithic in Eastern Hungary based on calibrated radiocarbon dates, 15^{th} International Radiocarbon Conference. Glasgow, Scotland, 15-19 Aug., 1994. (1994)
5. Hertelendi E., Veres M., Futó I., Mikó L., Lénárt L., Deák J., Süveges M., Radiocarbon concentration and origin of thermal karst water in the surrounding of the Bükk Mountains, 15^{th} International Radiocarbon Conference. Glasgow, Scotland, 15-19 Aug., 1994. (1994)
6. Veres M., Hertelendi E., Uchrin G., Csaba E., Barnabás I., Ormai P., Volent G., Futó I., Concentration of radiocarbon and its chemical forms in gaseous effluents, environmental air, nuclear waste and primary water of a pressurized water reactor power plant in Hungary, 15^{th} International Radiocarbon Conference. Glasgow, Scotland, 15-19 Aug., 1994. (1994)
7. Hunyadi I., Környezeti alfarádióaktivitás, IV. Kárpát-medencei Környezetvédelmi Konferencia. Debrecen, Magyarország, 1994.julius 30 - augusztus 1. (1994)
8. Varga K., Hunyadi I., Hakl J., Uzonyi I., Bacsó J., Gross alpha radioactivity and chemical trace element content of thermal waters measured by SSNTD and XRF methods, 17^{th} International Conference on Nuclear Tracks in Solids. Dubna, Russia. 22-28 Aug., 1994. (1994)
9. Hakl J., Hunyadi I., Varga K., Csige I., Determination of radon and radium content of water samples by SSNTD technique, 17^{th} International Conference on Nuclear Tracks in Solids. Dubna, Russia. 22-28 Aug., 1994. (1994)
10. Hunyadi I., Csige I., Géczy G., Hakl J., Radon doses received in speleotherapy courses in Hungary, 17^{th} International Conference on Nuclear Tracks in Solids. Dubna, Russia. 22-28 Aug., 1994. (1994)
11. Csige I., Hakl J., Vásárhelyi A., Hunyadi I., Radon transport in a drilled well studied by etched track type radon monitors, 17^{th} International Conference on Nuclear Tracks in Solids. Dubna, Russia. 22-28 Aug., 1994. (1994)
12. Pécskay Z., A fizika szerepe a földtani problémák megoldásában. (A tudományok határvonalainak elmosódása), Erdélyi Műszaki Tudományos Társulat. Kolozsvár, Románia, 1994. június 10. (1994)

13. Kovacs, M., Edelstein, O., Pécskay Z., Gábor M., Bernád, A., Crihán, M., Evolution of the Neogene volcanism in the Gutai Mts: A new approach, Centenarial Celebration of the Mineralogy Department of University Bucharest, Symposium. Bucharest, Romania, 10-12 May, 1994. (1994)

14. Pécskay Z., Edelstein, O., Seghedi, I., Szakács A., Kovacs, M., Crihán, M., Bernád, A., Recent K-Ar dating of Neogene-Quaternary volcanic rocks in the East Carpathians, Romania (Book of Abstacts Theme-5), IAVCEI Int.Volc.Cong., 1994. Ankara, Turkey, 12-16 Sept., 1994. (1994)

15. Karátson D., Pécskay Z., Kristó A., Remnant surfaces of different volcanic flows in the UPPER CSIKI (CIUC) Basin: Relief evolution of 5 to 6 Ma old volcano flanks in the Noth Harghita, East Carpathians (Book of Abstracts Theme-5), IAVCEI Int.Volc.Cong., 1994. Ankara, Turkey, 12-16 Sept., 1994. (1994)

16. Szakács A., Seghedi, I., Pécskay Z., Karátson D., Time-space evolution of Neogene-Quaternary volcanism in the Calimani-Gurghiu-Harghita volcanic chain (East Carpathians, Romania) (Book of Abstracts, Theme-5), IAVCEI Int.Volc.Cong., 1994. Ankara, Turkey, 12-16 Sept., 1994. (1994)

17. Pécskay Z., Edelstein, O., Seghedi, I., Szakács A., Kovacs, M., Crihán, M., Bernád, A., Recent K-Ar dating of Neogene-Quaternary volcanic rocks in the East Carpathians, Romania, Plate Tectonic Aspects of Alpine Metallogeny in the Carpatho-Balkan Region. Baia Mare, Romania. 13-14 June, 1994. (1994)

18. Karamata, S., Zivkovic, P., Pécskay Z., Knezevic, V., Cvetkovic, V., Geological setting and age of the Coka Marin polymetallic ore deposit (Eastern Serbia), Plate Tectonic Aspects of Alpine Metallogeny in the Carpatho-Balkan Region. Baia Mare, Romania. 13-14 June, 1994. (1994)

19. Kovacs, M., Edelstein, O., Bonhomme, M., Pécskay Z., Gábor M., Neogene magmatism and metallogeny in the Oas-Gutai-Tibles Mts.: A new approach based on the radiometric datings, Plate Tectonic Aspects of Alpine Metallogeny in the Carpatho-Balkan Region. Baia Mare, Romania. 13-14 June, 1994. (1994)

20. Hakl J., A természetes radioaktivitás, kockázat, biológiai hatások, Eszterházy Károly Tanárképző Főiskola, Eger, Magyarország, 1994. okt. 25. (1994)

21. Hakl J., A radontransport dinamikája a Vass Imre barlangban, Karsztfolyamatok kölcsönhatásának kutatási eredményei. Jósvafő, Magyarország, 1994. okt. 6-9. (1994)

22. Hakl J., Várhegyi A, Csige I., Barlangi légcsere dinamikai modellje-radonmérések alapján, MFT és MGE közös Vándorgyülése. Sárospatak, Magyarország, 1994. okt. 13-15 (1994)

23. Hertelendi E., Veres M., Futó I., Hakl J., Mikó L., Lénárt L., Environmental isotope study of karst systems, ISOKARST-94. Miskolc, Magyarország, 3. Oct., 1994. (1994)

24. Borbély-Kiss I., Koltay E., Szabó Gy., Mészáros E., Molnár Á., Bozó L., Particle characterization at rural, suburban and urban aerosol sampling sites in Hungary (Abstracts... Eds.: J.L. Duggan, I.L. Margan, Univ. of Texas, Dept.of Physics, 1994. p.134), 13^{th} International Conference on the Application of Accelerators in Research and Industry. Denton, Texas, USA, 7-10 Nov., 1994. (1994)

25. Koltay E., Kiss Á.Z., Somorjai E., Characterization of aerosols with other IBA techniques: PIGE and RBS, Seminario Aplicación de las Técnicas Analiticas con Haces Iones (PIXE, PIGE, etc.) para la Caracterización de Aerosoles Ambientales. Madrid, Spain, 28-29.Nov., 1994. (1994)

26. Borbély-Kiss I., Koltay E., Szabó Gy., Mészáros E., Molnár Á., Bozó L., PIXE, PIGE and their capabilities for source apportionment, Seminario Aplicación de las Técnicas Analiticas con Haces Iones (PIXE, PIGE, etc.) para la Caracterización de Aerosoles Ambientales. Madrid, Spain, 28-29. Nov., 1994. (1994)
27. Csige I., With track detectors from space to caves, Jozef Stefan Institute. Ljubljana, Slovenia, Dec. 8, 1994. (1994)
28. Pécskay Z., Karamata, S., Djordjevic, M., Knezevic, V., Magmatism of the Ridanj-Krepoljin Belt (Eastern Serbia) and their correlation with northern and eastern analogues, Modelling Workshop on Metallogeny and Igneous Activity in the Southern Carpathians. Donji Milanovac, Serbia, Nov. 1, 1994. (1994)
29. Komlóssi Gy., Pécskay Z., Szalay E., Vetőné Ákos É., Zelenka T., Az alpi metallogenezis és a lemeztektonika kapcsolata a Kárpát-Balkán régióban. Beszámoló az IGCP 356 project 1994. évi nagybányai üléséről, ELTE TTK Ásványtani Tanszék. Ásványtan-Geokémiai Szakosztály. Budapest, Magyarország, 1994. október 24. (1994)
30. Figler A., Bartosiewitz L., Hertelendi E., Füleky Gy., Cooper age settlement and the Danube water system: A case study from North-West Hungary, Landscapes in Flux the 2^{nd} CITTEE Conference. Newcastle Upon Tyne, United Kingdom. 11-13 March, 1994. (1994)
31. Uray I., Lakossági sugárterhelés Csernobil környéki szennyezett területeken, ELFT XIX. Sugárvédelmi Továbbképző Tanfolyam. Balatonkenese, Magyarország, 1994. május 3-5. (1994)
32. Vásárhelyi A., Csige I., Hunyadi I., A talajgáz és a kútvizek radontartalmának vizsgálata Mátraderecskén, ELFT XIX. Sugárvédelmi Továbbképző Tanfolyam. Balatonkenese, Magyarország, 1994. május 3-5. (1994)
33. Hunyadi I., Kertész Zs., Maucha G., Radonmérések az István-lápai barlangban, Karsztfolyamatok kölcsönhatásának kutatási eredményei. Jósvafő, Magyarország, 1994. okt. 6-9. (1994) 21
34. Géczy G., Hunyadi I., Csige I., Hakl J., A karsztok légkörzési modellje, Karsztfolyamatok kölcsönhatásának kutatási eredményei. Jósvafő, Magyarország, 1994. okt. 6-9. (1994)
35. Uchrin G., Csaba E., Volent G., Hertelendi E., Tritium and Carbon-14 discharge monitoring at Paks nuclear power plant, 25^{th} International Symposium on Radiation Protection Physics. Dresden, Germany, 26-30 Sept, 1994. (1994)
36. Hertelendi E., Csongor J., Mikecz P., Sándor Lné, Veres M., Kis és közepes aktivitású hulladékokban eljárás kidolgozása a ^{99}Tc illetve a ^{3}H koncentrációjának meghatározására és a ^{99}Tc/^{137}Cs scaling factor becslésére, Atomki, Debrecen (1993) 18
37. Hertelendi E., Sándor Lné, Veres M., A Paksi Atomerőműből kibocsátott ^{14}C mérése a környezetben, Atomki, Debrecen (1993) 24
38. Hertelendi E., Veres M., A Paksi Atomerőműből a talajvizbe jutó triciummal szennyezett víz eredetének és a szennyezés mértékének vizsgálata, Atomki, Debrecen (1993) 101
39. Hertelendi E., Sándor Lné, Veres M., Mintavételezési elválasztási és aktivitásmérési eljárás kidolgozása atomerőműből származó ^{85}Kr kibocsátás mérésére, Atomki, Debrecen (1993) 16
40. Hertelendi E., Sándor Lné, Veres M., Paleokarsztok izotópanalitikai vizsgálata, Atomki, Debrecen (1993) 18

41. Hertelendi E., Sándor Lné, Veres M., Vízgeológiai kutatások project, izotóphidrológiai vizsgálatok, Atomki, Debrecen (1993) 28
42. Hertelendi E., Sándor Lné, Veres M., A Dél-Alföldi löszképződmények keletkezésének paleoökológiai rekonstrukciója, Atomki, Debrecen (1993) 15
43. Árva-Sós E., Balogh K., A Nyugat-mecseki neogén részletes vizsgálata c. F7421.sz. OTKA keretében végzett K/Ar kormeghatározások. A Mecsek Ércbányászati Váll. és az Atomki 105/94.sz. szerződés keretében. Témavez.:Árváné Sós E., Atomki, Debrecen (1994) 18
44. Árva-Sós E., Balogh K., K/Ar kormeghatározások a JATE Ásványtani, Geokémiai és Kőzettani Tanszékének a T-4158 sz. OTKA ...kutatásaihoz 1994-ben. Jelentés. A JATE ÁGKT ... és az Atomki ... 84/94 sz. keretében... Témavezető: Árváné Sós E., Atomki, Debrecen (1994) 26
45. Árva-Sós E., Balogh K., K/Ar kormeghatalmazások mecseki variszkuszi aplitokon és milonitokon. Jelentés az ELTE Kőzettan-Geokémiai Tsz. és az Atomki között létrejött...498/94 sz.szerződés, Atomki, Debrecen (1994) 8
46. Árva-Sós E., Balogh K., K/Ar kormeghatározás az ELTE Kőzettan-Geokémiai Tanszékének a T-4194.sz. OTKA keretében folyó kutatásaihoz, 1994-ben. (432/94. sz. alvállalkozói szerződés). Témavezető: Árváné Sós E., Atomki, Debrecen (1994) 5
47. Árva-Sós E., Balogh K., K/Ar kormeghatázorások a JATE Ásványtani, Geokémiai és Kőzettani Tanszékének a T-OO7346.sz. OTKA keretében folyó kutatásaihoz (193/94.sz. alvállalkozói szerződés) Témavezető:Árváné Sós E., Atomki, Debrecen (1994)
48. Hertelendi E., Futó I., Svingor É., Veres M., A dél-alföldi löszképződmények keletkezésének paleoökológiai rekonstrukciója, Atomki, Debrecen (1994) 1
49. Hertelendi E., Futó I., Svingor É., Veres M., Primerköri hőhordozóban jelenlevő ^{14}C kémiai formái, Atomki, Debrecen (1994) 15
50. Hertelendi E., Futó I., Svingor É., Veres M., Kombinált ^{14}C-T környezeti mintavevő kifejlesztése, Atomki, Debrecen (1994) 8
51. Hertelendi E., Futó I., Svingor É., Veres M., Nyomjelzéses technika kidolgozása az atomerőműből talajvízbe jutó szennyezett víz (tríciumos víz) kijutási helyeinek meghatározására, Atomki, Debrecen (1994) 35
52. Hertelendi E., Futó I., Svingor É., Veres M., Nyomjelzéses eljárások kidolgozása, azok alkalmazása az ellenőrzött zónán belül, Atomki, Debrecen (1994) 11
53. Hertelendi E., Csongor J., Gulyás J., Szűcs Z., Svingor É., Veres M., Bepárlási maradék ^{129}I koncentráció meghatározási módszerének kidolgozása, Atomki, Debrecen 1 (1994) 12
54. Hertelendi E., Futó I., Kiss J., Svingor É., Szádai J., Veres M., Primerköri hőhordozó gáztartalmának vizsgálata, Atomki, Debrecen (1994) 8
55. Hertelendi E., Veres M., Futó I., Hakl J., Mikó L., Lénárt L., COST-65 action, National Report, Hungary, 1994 Atomki, Debrecen (1994) 18
56. Hertelendi E., Veres M., Futó I., Hakl J., Mikó L., Lénárt L., Hydrogeological aspects of groundwater protection in karstic areas COST-65 progress report, Atomki, Debrecen (1994) 66
57. Pécskay Z., A fizika szerepe a földtani problémák megoldásában. (A tudományok határvonalainak elmosódása), Erdélyi Műszaki Tudományos Társulat. Kolozsvár, Románia, 1994.június 10. (1994)
58. Uray I., Csernobil üzenete. A katasztrófa mérlege nyolc év távlatából, Debreceni Szemle **2** (1994) 171

59. Uray I., Hille, R., Messprogramm der Bundesrepublik Deutschland, externe Strahlenbelastung der Republiken Russland und Weissrussland im Sommer 1992, Berichte der Forschungszentrums Jülich 2729 (1993) 1

Biological and Medical Research

1. Béres Cs., Fenyvesi A., Ridder, H.-W., Raschi, A., Fás szárú növények komplex, műszeres vizsgálata (Absztraktgyüjtemény pp. 28-29), Erdő és Klíma Konferencia. Noszvaj, Magyarország, 1994. június 1-3. (1994)
2. Fenyvesi A., Béres Cs., Röfler J., Fák nedvszállításának vizsgálata termometriás módszerrel. (Előadás kivonatok, 9.oldal), Szegedi Ökológiai Napok 24. Tiszakutató Ankét. Szeged, Magyarország, 1993. nov. 3-5. (1994)
3. Fenyvesi A., Béres Cs., Röfler J., Fák nedvszállításának vizsgálata termometriás módszerrel (Absztraktgyüjtemény 30.oldal), Erdő és Klíma Konferencia. Noszvaj, Magyarország, 1994. június 1-3. (1994)
4. Raschi, A., Ridder, H.-W., Tognetti, R., Béres Cs., Fenyvesi A., Studying trunk water relations by CT: concurent measurements of xylem cavitation and sap velocity in two different quercus species (Kurzfassungen der Referate, p.8), Workshop: "Die Computer-Tomographie als Diagnostische Methode bei der Untersuchung von Baumen", Marburg, Deutschland, März 23, 1994. (1994)
5. Fenyvesi A., Béres Cs., Röfler J., Csiha I., Sap-flow measurements on trees by a heat balance method, 1^{st} International Conference on Food Physics. Budapest, Hungary, 25-27 May, 1994. (1994)
6. Bohátka S., Langer G., Simon M., Futó I., Fekete S., Gál I., Szádai J., Székely G., Bálint J., Mass spectrometry system for in-vivo monitoring of gas exchange in plants. (Final Programme 4^{th} EVC, Abstracts, VSC7), 4^{th} European Vacuum Conference (EVC-4). Uppsala, Sweden, 12-17 June, 1994. (1994)
7. Bohátka S., Lakatos Gy., Makádi M., Simon M., Mass spectrometric monitoring of reed decay (Book of Abstracts, p.295), 13^{th} International Mass Spectrometry Conference. Budapest, 29 Aug. - 2 Sept., 1994. (1994)
8. Béres Cs., Fenyvesi A., The role of computer tomographical methods in investigation of water transport in oak trees (Presentation and Poster Abstracts), First European Symposium on Nondestructive Evaluation of Wood. Sopron, Hungary, 21-23 Sept., 1994. (1994)
9 Szűcs Z., Milesz S., Norseev, Yu.V., Vasáros L., Labelling of monoclonal antibody with astatine via At(DTPA) complex (Abstr.:European Journal of Nuclear Medicine, 21, 1994, No.l0, p.503), 6^{th} World Congress of World Federation of Nuclear Medicine and Biology. Sydney, Australia, 23-28 Oct., 1994. (1994)
10. Mahunka I., Ciklotron a biológiában, A Magyar Biofizikai Társulat Radioökológiai Szakosztálya és a DAB Környezettudományi Szakbizottság Szárazföldi Ökológiai Munkabizottság Ülése, Debrecen, Magyarország, 1994. okt. 26. (1994)
11. Fenyvesi A., Vízforgalmi mérések fákon, A Magyar Biofizikai Társulat Radioökológiai Szakosztálya és a DAB Környezettudományi Szakbizottság Szárazföldi Ökológiai Munkabizottság Ülése, Debrecen, Magyarország, 1994. okt. 26. (1994)

Development of Instruments and Methods

1. Biri S., Status of the ECR program of the Atomki, Institut für Kernphysik, Universität Frankfurt/Main. Frankfurt/Main, Germany, 25. Febr., 1994. (1994)
2. Kormány Z., Valek A., Dworschak, F., Kogler, W., Stellmacher, W., Advanced beam diagnostics for a compact cyclotron, Fourth European Particle Accelerator Conference. London, United Kingdom, June 27 - July 1, 1994. (1994)
3. Varga K., Hunyadi I., Hakl J., Uzonyi I., Bacsó J., Gross alpha radioactivity and chemical trace element content of thermal waters measured by SSNTD and XRF methods, 17^{th} International Conference on Nuclear Tracks in Solids. Dubna, Russia. 22-28 Aug., 1994. (1994)
4. Hakl J., Hunyadi I., Varga K., Csige I., Determination of radon and radium content of water samples by SSNTD technique, 17^{th} International Conference on Nuclear Tracks in Solids. Dubna, Russia. 22-28 Aug., 1994. (1994)
5. Hunyadi I., Csige I., Géczy G., Hakl J., Radon doses received in speleotherapy courses in Hungary, 17^{th} International Conference on Nuclear Tracks in Solids. Dubna, Russia. 22-28 Aug., 1994. (1994)
6. Csige I., Hakl J., Lakatos I., Measurement of effective diffusion coefficient of radon in porous media with etched track radon monitors, 17^{th} International Conference on Nuclear Tracks in Solids. Dubna, Russia. 22-28 Aug., 1994. (1994)
7. Bohátka S., Mass spectrometry in processes control and monitoring (Book of Abstracts, p.6), 13^{th} International Mass Spectrometry Conference. Budapest, 29 Aug. - 2 Sept., 1994. (1994)
8. Simon M., Bohátka S., Trajber Cs., Experimental verification of an improved prefilter model (Book of Abstracts, p.333), 13^{th} International Mass Spectrometry Conference. Budapest, 29 Aug. - 2 Sept., 1994. (1994)
9. Biri S., Vámosi J., The Debrecen-ECRIS: magnetic trap visualisation and particle movement simulation, 29^{th} European Cyclotron Progress Meeting. Dubna, Russia, 20-22 June, 1994. (1994)
10. Pál K.F., Selection schemes with spatial isolation for genetic optimization, International Conference on Evolutionary Computation, the Third Conference on Parallel Problem Solving from Nature. Jerusalem, Izrael, 9-14 Oct.,1994. (1994)
11. Oda, K., Csige I., Yamauchi, T., Miyake, H., Benton, E.V., Incident angle dependence of proton response of CR-39 (TS-16) track detector, 16^{th} International Conference on Nuclear Tracks in Solids. Beijing, China, 7-11 Sept., 1992. (1994)
12. Víkor Gy., Additional equipment of the ESA-21 electrostatic spectrometer in Debrecen, Institut za Elektronsku Fiziku, Uzhgorod, Ukraine, March 14, 1994. (1994)
13. Lindblad, Th., Lindsey, C.S., Minerskjöld, M., Sekhniaidze, G., Székely G., Eide, Á., Implementing the new Zero Instruction Set Computer (ZISC036) from IBM for a Higgs search, Royal Institute of Technology, Stockholm (1994) 3
14. Eide, Á., Lindblad, Th., Lindsey, C.S., Minerskjöld, M., Sekhniaidze, G., Székely G., An implementation of the Zero Instruction Set Computer (ZISC036) on a PC/ISA-bus card, Royal Institute of Technology, Stockholm (1994) 14
15. Agehed, K., Eide, Á., Hultberg, S, Lindblad, Th., Lindsey, C.S., Minerskjöld, M., Molnár J., Sekhniaidze, G., Székely G., Progress report on the design and performance of a VME-ATM module using dual-ported memories, TRITA FYS 9008 CERN Nebulas Note 94-1 Rev.0.1 (1994) 1

16. Dajkó G., Elrendezés folyadékok mikorszűrésére nukleáris úton előállított membránokkal, Bejelentés időpontja 1993.február 26., Elfogadás ideje: 1994.szeptember 28. Száma: T/66091 (1994) 4

Science and Society

1. Berényi D., Felesősségünk a világ jelenéért és jövőjéért, Fizikus Klub, Debrecen, Magyarország, 1994. febr. 24. (1994)
2. Berényi D., Mit tudunk a világmindenség fejlődéséről és szerkezetéről? Katolikus Szülők Egyesülete. Debrecen, Magyarország, 1994. május 17. (1994)
3. Berényi D., Hogyan látja a tudomány ma a világmindenséget és fejlődését? Szent Anna Nyugdíjas Klub. Debrecen, Magyarország, 1994. május 4. (1994)
4. Berényi D., A Debreceni Szemle bemutatása, DAB Klub, Debrecen, Magyarország, 1994.április 21. (1994)
5. Berényi D., A világmindenség, amiben élünk, Debrecen, Félkész Klub, 1994. április 20. (1994)
6. Berényi D., Tudásunk a világmindenségről, Piarista Diákszövetség. Debrecen, Magyarország, 1994.április 13. (1994)
7. Berényi D., Mit tudunk a világmindenségről? Nyugdíjas Akadémia. Debrecen, Magyarország, 1994.április 13. (1994)
8. Berényi D., A fizika aktualitása - jelene és jövője, XXXVII. Országos Középiskolai Fizikatanári Ankét. Debrecen, Magyarország, 1994. április 7. (1994)
9. Berényi D., Development or misdevelopment? - What lies ahead for humankind? An Integrated Approach to Science and Technology Policy. Academia Europaea Study Group. Alvor, Portugal, 9-11 March, 1994. (1994)
10. Berényi D., Megalakult az Akadémia Kutatásértékelési Bizottsága, Magyar Tudomány **39** (1994) 720
11. Berényi D., A DAB tervei a következő hároméves akadémiai ciklusra, Debreceni Szemle **2** (1994) 135
12. Berényi D., A tudomány a jövő Európájában, Debreceni Szemle **2** (1994) 163
13. Berényi D., Fejlődés vagy tévút - merre van előre az emberiség számára? Magyar Tudomány **39** (1994) 984
14. Berényi D., A szinkrotron-sugárforrások legújabb fejlődése, Fizikai Szemle **44** (1994) 285
15. Berényi D., Tudomány a ma társadalmában, Nyári Egyetem. Debrecen, Magyarország, 1994. jul. 28. (1994)
16. Berényi D., Erőfeszítéseink Bay Zoltán intézet létrehozására Debrecenben, Debreceni Szemle **2** (1994) 313
17. Berényi D., Kit válasszunk az Akadémia tagjává? Magyar Tudomány **39** (1994) 1096
18. Berényi D., Felelősségünk a világ jelenéért és jövőjéért, Magyar Szemle **3** (1994) 949
19. Berényi D., "George Marx: The voice of the Martians" R.Eötvös Phys.Soc., Bp., 1994. Könyvismertetés, Fizikai Szemle **44** (1994) 378
20. Berényi D., Tudomány és társadalom a XX. század végén, Félkész-klub, Debrecen, Magyarország, 1994. okt. 5. (1994)

21. Berényi D., A tudomány és a gazdasági fejlődés. Vitaindító, TIT Jurányi Lajos Egyesülete Sponzorainak összejövetele. Debrecen, Magyarország. 1994. szept. 19. (1994)
22. Berényi D., Responsibility of intellectuals in our time, International Conference on Peace Human Rights and the Responsibility of Intellectuals. Opatia, Croatia, 29. Sept. - 2. Oct., 1994. (1994)
23. Medveczky L., Szalay Sándor (1909. október 4 - 1987. október 11), Debreceni Szemle **2** (1994) 582
24. Vad K., Szupravezetés, Varga Katalin Gimnázium, Szolnok, Magyarország. 1994. nov. 23. (1994)
25. Török I., A tisztább atomenergia reménye, Debreceni Szemle **2** (1994) 190

Theses completed

Academic Doctor of Sciences Degree

1. Kiss Á.Z., **Stopping power of materials and the slowing-down Doppler-shift of gamma-ray energies in nuclear spectroscopy** (in Hungarian), Atomki, Debrecen (1992) 97

Academic Candidate of Sciences Degrees

1. Dombrádi Zs., **The effect of nuclear core on the splitting of proton-neutron multiplets in $^{104-116}$In and $^{116-124}$Sb nuclei** (in Hungarian), Atomki, Debrecen (1993) 87
2. Gulyás J., **The structure of ^{106}In and ^{118}Sb nuclei** (in Hungarian), Atomki, Debrecen (1993) 112
3. Gácsi Z., **The structure of ^{114}Sb, ^{116}Sb, and ^{116}Sn nuclei** (in Hungarian), Atomki, Debrecen (1993) 77
4. Vad K., **Weak superconductivity and its applications** (in Hungarian), Atomki, Debrecen (1993) 79
5. Dajkó G., **Study of neutron detection by solid state track detectors** (in Hungarian), Atomki, Debrecen (1993) 103

University Doctoral Degree (PhD)

1. Némethy A., **Experimental study of K-Auger transitions and their dependence on chemical conditions** (in Hungarian), Atomki, Debrecen (1994) 88
2. Vámosi J., **Modeling and plasma-physical study of magnetic trap of electron-cyclotron-resonance heavy-ion source** (in Hungarian), Atomki, Debrecen (1994) 86

Diploma Works

1. Varga Z., **Development of a multy-component charged-particle detector and its application in heavy-ion nuclear reactions** (in Hungarian), Supervisor: Nyakó B., Atomki, Debrecen (1994) 56
2. Csák Cs., **Measuring nuclear reaction cross sections at a cyclotron for applications** (in Hungarian), Supervisor: Tárkányi F., Atomki, Debrecen (1994) 50

3. Foltin E., **Application of Rutherford-backscattering for studying samples of different thickness** (in Hungarian), Supervisor: Kiss Á.Z., Atomki, Debrecen (1994) 49
4. Végvári Zs., **Study of post-collision interaction (PCI) in processes with proton bombardment** (in Hungarian), Supervisor: Sarkadi L., Atomki, Debrecen (1994) 40
5. Balogh T., **Development of a program used for the (XRF) determination of the composition of gold jewellery** (in Hungarian), Supervisor: Bacsó J., Atomki, Debrecen (1994) 62
6. Novák D., **Application of VLSI neural network for large scale data processing** (in Hungarian), Supervisor: Molnár J., Atomki, Debrecen (1994) 64

HEBDOMADAL SEMINARS

January 20
Nuclear astrophysics
D. Baye (Université Libre de Bruxelles)

January 25
Multiple excitation in ion-atom collisions
A. Salin (University of Bordeaux)

February 3
Physical phenomena in nanostructures
A. Zawadowszky (Institute of Solid State Physics, Budapest)

February 4
Investigation of one- and two-electron processes by zero-degree electron spectroscopy in fast atomic collisions
P. Závodszky

February 17
Measurement of the $^{150}Nd(\alpha, \alpha')$ inelastic scattering and determination of ratio β_2/β_{2c}
A. Krasznahorkay

February 24
Processing of detector's signal
Gy. Hegyesi and L. Lakatos

March 3
Crystallines, glasses, layers - material research at the State University of Uzhgorod
S. Kökényesi (State University of Uzhgorod)

March 17
The new computer network of ATOMKI
G. Székely

March 24
High-energy heavy-ion physics in region 100 Mev*A - 170 GeV*A
Z. Fodor (Particle and Nuclear Research Institute, Budapest)

April 7
Evaluation of the safety of Paks Nuclear Power Station
J. Gadó (Atomic Energy Research Institute, Budapest)

April 14
"Hidden" world of virtually excited clusters in nuclei and its

expected reveal in cluster quasi-elastic knock-out by 1 GeV protons
V. G. Neudatchin (Moscow State University)

May 5
Collective excitatitions in systems of electrons - plasmons in fullerenes
B. Vasváry (Physics Department, Technical University, Budapest)

June 30
Concentration of toxic heavy metals and other air pollutants
in airborne particles in Debrecen city (Defence of Thesis)
Ali Atef. E. (Minia University, Egypt)

July 7
3rd generation of synchrotron radiation research center facilities
Y. C. Liu (Synchrotron Radiation Research Center, Hsinchu, Taiwan)

September 29
K-Auger transitions and their dependence on the chemical enviroment
A. Némethy

October 6
The Delphi detector at the large electron-positron collider at CERN
H. Herr (CERN)

October 13
4π charged-particle detector for the EUROBALL
B. Nyakó, J. Gál and G. Kalinka

October 19
Physics with large γ-ray detector arrays
J. F. Scharpey-Schafer (University of Liverpool & CRN, Strasbourg)

October 21
Mirror symmetry in the nature
Gy. Deutsch (Catholic University, Louvain)

October 28
Enviromental impact of the Paks Nuclear Power Station
E. Virág (Paks)

November 1
The magnetic system of the ECR ion source
J. Vámosi

November 3
Traffic jams and sand avalanches: driven systems with a large numbers of degree of freedom
J. Kertész (Technical University, Budapest)

November 17
Measurement of radon transport
I. Csige

November 24
Metastabil antiprotonic hadronic atoms
D. Horváth

December 1
Genetic algorithms
K. F. Pál

December 8
High-intensity neutron sources
F. Mezei (Hahn-Meitner Institute, Berlin)

Author Index

(* denotes author from other establishment)

Kiadja a
Magyar Tudományos Akadémia Atommagkutató Intézete
A kiadásért és szerkesztésért felelős
Dr. Pálinkás József, az Intézet igazgatója
Nyomdai munkák: PÉJ Bt. Tel.: (52) 324-719
Törzsszám: 65786
Debrecen, 1995 április